THE

# ELECTRICAL REVIEW.

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## "ELECTRICAL REVIEW."

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THE

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## ELECTRIC TRACTION ON RAILWAYS.

DURING the last two years we have several times expressed our views upon the subject of the electrification of suburban steam railway lines, and so far we have seen no reason to retreat from the position we have taken up. The further we investigate the problem the more firmly are we convinced that our views are correct. Serious difficulties will, doubtless, be encountered in carrying out the transformation, but they are not insurmountable, and will not be allowed by engineers to stand in the way of ultimate success.

One of the chief obstacles to be overcome is the difficulty, in many instances, of finding space for the location of a third rail. In the great London termini, and in many of the suburban stations, there is such a maze of tracks that there is practically no room for an extra rail; even where the ground is not actually occupied by the tracks, such space as is left is more or less filled up with rods and wires for working points and signals. The platelayers have great difficulty in finding time to maintain and repair the track as it is, and it would be practically impossible for them to keep the third rail construction in order as well. And then there is the question of danger; railway officials are obliged to constantly cross the tracks, and have enough to do in keeping out of the way of passing trains without thinking of steering clear of "live" rails.

It has always been admitted by those best acquainted with the conditions of standard railway practice that the single-phase alternating current system is the ideal one, if practicable. There are three chief reasons for this—first, the desirability, and in some cases necessity, of doing away with the conductors in or near the track; second, the practical necessity for a *single* insulated conductor, whether it be overhead or on the ground; third, the fact that a large amount of power must be taken from the conductor to operate at high speeds the heavy trains which will be required. With the direct current system the necessarily limited voltage involves the collection of a very heavy current from the conductor; with an alternating current system, the limit may be anything up to 10,000 or even 20,000 volts, so that the current need not be excessive.

We had these facts in mind when, on the occasion when Mr. Lamme, of the Westinghouse Co., read his paper on single phase motors for traction purposes, we stated that if the problem had really been solved by this means, the consequences would be most far-reaching; since that time we have learnt that Dr. Finzi, of Milan, had already given his attention to the same subject and practically designed such a motor, simultaneously with, if not before, the experiments of the Westinghouse Co., and a paper by Dr. Finzi describing his motor is concluded elsewhere in this issue. Though Mr. Lamme's system had no doubt very great advantages over anything that had previously been done, at the same time we

were not convinced that all the difficulties of commutation had been overcome, and the facts that very low periodicities must be used, that a transformer, practically equal in size to the motor, must be carried, and unless complicated windings were introduced, only one line pressure could be utilised, were sufficient to produce in the minds of engineers a very natural hesitation in adopting a system so evidently in its experimental stage.

In discussing the railway proposition, we wish to state emphatically that we are in no way considering the so-called high-speed electric railways, as we think that, with very few exceptions, as high a speed as is necessary could, if called for, be reached on the long-distance lines by the use of steam locomotives. This has been repeatedly demonstrated by trains drawn by steam locomotives exceeding 90 miles an hour, and it is very much to be questioned whether in the present state of affairs any great advantage would result to railway companies from the introduction of high-speed electric traction on their lines. We look on the Berlin-Zossen trials as a costly experiment paid for by a few German manufacturers, assisted by Government, an experiment which has been very ably exploited as a colossal advertisement by the respective firms.

No practical engineer who has seen the Berlin-Zossen line in operation could imagine for a single moment that the system is possible for adoption in ordinary railway working. The experiment is considered a dangerous one for all concerned, and no representatives or officials of any Government or private railways have as yet been allowed to take part in a run. We have been solemnly informed by engineers concerned in the test that even the Prussian Minister of Railways is not allowed to risk his life in a trial unless he brings an indemnity amounting to £10,000 or £20,000, signed by one of the large German Banks, and the charge for such an indemnity, as far as we have been able to ascertain, is very considerable. At speeds of over 100 miles an hour the question of brakes and of signals is of paramount importance, and that this problem has not been solved is fully borne out by the results which have so far been obtained.

Apart from the use of electric traction on suburban lines, the possible ultimate extension of it to main lines is quite a different question, and has engaged the attention of the engineers of all countries for some time. We believe that the solution of this difficult and important problem has at last been found; but before going into any further details it may be as well to consider some of the conditions which electric traction has to fill, in order to be applicable to, and give the best results for, railway work.

*First;* the conductors carrying current to trains must be as few as possible and must not interfere with the tracks.

*Secondly;* it must be possible to collect from a single conductor sufficient power to haul one or more fast trains in service on the lines between feeding points of the conductor.

*Thirdly;* it is very desirable that the system should be applicable to main line as well as suburban traction, and that it should be possible to utilise at least two working pressures, a low pressure in or near the stations, and a higher pressure outside.

*Fourthly;* the system should be such that trains can be operated with equal facility either with locomotives, motor-cars, or on the multiple unit system.

*Fifthly;* all controlling apparatus must be of the very simplest character, and such that no skilled labour is necessary to operate the trains; also there must be no dangerous high pressure anywhere accessible to either railway officials or passengers.

*Sixthly;* if alternating currents are used it is essential that the power factor be high and the motor be capable of giving an acceleration equal to that obtained with the best series-wound direct current motors at present in use.

*Seventhly;* in certain cases it might be advantageous for the motor to be constructed to return current to the line, and in any case it must be constructed to reverse and to be used for braking purposes.

These conditions are so stringent that it would appear impossible for any motor, especially a simple alternating current motor, to fulfil them; yet this apparent impossibility is at the present moment an accomplished fact, a most simple solution of all the difficulties having been found by Messrs. Eichberg & Winter, engineers of the Union Elektricitäts Gesellschaft, of Berlin. We have satisfied ourselves that the claims made for this motor are perfectly justified, but at present we are not at liberty to go into constructive details or to give our readers the methods by which the results mentioned have been attained, although we hope to be able to do this at no very distant date. Our readers must be satisfied with the results which we now give.

In outward appearance the motor does not differ materially from the well-known G.E. direct current motor; the outside dimensions for any given power are practically identical. All the standard direct current controlling apparatus, either of the ordinary series-parallel or the multiple-unit type, including the automatic switches which have proved so successful, are applicable to the alternating current system, the only difference being that, to all intents and purposes, there are no resistances, and that the number of controller contacts for giving variations in speed is less in the alternating than in the direct current system.

The total weight of alternating equipment is not greater than that of an equivalent direct-current equipment, and the wiring is simpler. The motors can be coupled in parallel or in series, and can be used in identically the same way as continuous-current traction motors of the present day. The power factor at normal speed is unity, and as that for the lowest starting speeds is very little below ·8, the average power factor for the complete system would probably be in the neighbourhood of ·9, which is practically as good as what is now obtained where rotary converters are used. The efficiency is practically the same as that of an equivalent continuous-current motor, and the average acceleration obtainable is quite as good, with the additional advantage that the rate is as nearly as possible uniform during the total period of acceleration, which is not the case with continuous-current motors. Another remarkable point about this motor is that it combines the best features of both the series and shunt-wound continuous-current motor. The same motor by simply changing one connection can be used as either a series or shunt machine.

These motors are being manufactured on a commercial scale, and a car weighing nearly 52 tons, equipped with four 125-H.P. motors, worked by a multiple unit controller, is now in regular operation on a branch line of the Berlin railways between Nieder Schöneweide and Spindlersfeld. The motors are so arranged that the commutator only takes a low-pressure current, the voltage of which, however, may be as high as 600 volts, if desired. The high-pressure current need not pass through any transforming device, and its voltage, except for insulating reasons, can be raised as high as wished. Any periodicity can be used as far as the motor is concerned. At present a periodicity between 25 and 40 cycles is used, and has given perfect satisfaction. In one case the voltage is arranged in such a way that the high-pressure current utilised in the stator is supplied at 6,000 volts, the induced current in the revolving armature being generated at 600 volts; with this arrangement it is possible, by the addition of one contact on the controller, to operate the motor either at 600 or 6,000 volts from a single trolley wire, the motor giving identically the same results in either case.

It will be seen that the claims of this motor are such as to be scarcely credible, but we have our information from a perfectly reliable source, and we are quite satisfied that the claims are founded on facts. There is nothing of an experimental nature about it, and the controlling devices are identical with the well-known apparatus used in continuous-current traction. This discovery will mark a new era in the application of electricity to main lines, for the results so far obtained practically solve the traction problem. This, however, is not all, as the motor is so simple in construction and regulation and so versatile, that in the near future it should undoubtedly displace not only continuous-current motors, but all polyphase motors as well. Polyphase installations appear to be doomed, and we may even see a return to single-phase distribution at 25 or 50 cycles for all purposes.

We may be considered rash and hasty in the statements which we have made, but, as our readers know, we have always been conservative in the past and would never have gone so far in our conclusion had there been anything of an

experimental nature in the system or in the results which we have given, and with the accuracy of which we are fully satisfied.

Should our prophecy be realised, a further triumph will have been scored by Mr. Ferranti; for it is well known, and he has publicly declared, that he is convinced that single-phase electricity supply will ultimately supersede all its competitors.

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The Birthday Honours and Science.

THE list of appointments made on the occasion of his Majesty's birthday was published in the papers on Monday last. It ranges from Baronetcies to Companionships in the Imperial Service Order. It contains the names of 125 more or less distinguished personages. Among those 125 it contains the names of 11 men who have been awarded social distinction for those classes of work which are usually and conventionally designated scientific. To particularise, the list comprises 52 admissions or promotions among baronetcies, knighthoods, and in the Orders of the Bath, and of St. Michael and St. George. Of these 52, five are engineers, two are doctors, and one is a metallurgist, a total of eight; but among these eight there are three Royal Engineers and one army doctor. As representatives of civilian science, we have, therefore, four names left: Prof. C. Le Neve Foster, F.R.S., who has been given a Knighthood; Dr. A. R. Manby, Surgeon-Apothecary to the King and Prince of Wales at Sandringham, also given a Knighthood; Mr. C. Sandiford, Principal Engineer on the Uganda Railway, made a C.B.; and Mr. R. Anderson, Deputy-Engineer of the same line, made a C.M.G. We find no mechanical or electrical engineers or chemists here. In the Royal Victorian and the Imperial Service Orders, 73 names appear, these include Dr. R. Bell, a physician and geologist; Mr. C. W. Darley, Engineer-in-Chief for Public Works in New South Wales; and Mr. H. J. Helm, Deputy-Principal of the Government (chemical) Laboratory, Inland Revenue Department. Thus we have out of 125 men whose services to the nation have been deemed worthy of official recognition, seven exponents of non-military science, and nearly all of these hold some more or less Government appointment. It is a caustic commentary upon the low value set on scientific ability and research in the British Empire.

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Illicit Commissions.

IT will be gathered from the report of the Electrical Contractors' Association, appearing in another part of this paper, that the custom of consulting engineers and architects receiving commissions from contracting firms is by no means uncommon, though we are glad to find that some have the courage to publicly protest against it. Whether it is more common among a certain class of architects than it is among consulting engineers generally, we do not know, but that it is quite a common thing for a commission to be paid both by the contractor and the client is only too true. We have discussed the matter with architects, who say that it would be quite impossible to make ends meet on a basis of 5 per cent. commission on the contract price for small work, and that if they specify that special materials shall be obtained from certain manufacturers or supply houses, they are quite entitled to, and look for, a commission from these firms on the cost of the goods ordered from them. They say that they cannot leave it open to contractors to supply any accessories or fittings they care to put in, and it is quite necessary for them to specify goods with which they have had experience and know to be satisfactory. We can only repeat as we have said before so often, that the acceptance of a fee or commission from the contracting firm who is working under a specification of an architect or a consulting engineer, is not only immoral, but also illegal, and that both parties concerned are liable to prosecution, and the amount of the fee or commission paid can be recovered by the client from the contractor.

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Drying Combustibles.

ANY attempt to employ electricity as a drying agent should only be made where the value of the dried substance is considerable. As a drying agent electricity can only produce as much heat as is represented by the Joule's equivalent of the energy employed to generate it. The Joule equivalent of electricity at the switchboard is about one-tenth to one-twentieth of the calorific capacity of the fuel on the stoking floor. About one-fifth of this heat goes up the chimney, so that the waste gases are double or quadruple the value of the electricity. 70 to 75 per cent. of the fuel energy is to be found in the exhaust steam. Electricity is out of the question as a heating agent in affairs commercial, except when, as above stated, the article warmed has a value out of proportion to its mass. Substances which are valued in shillings and pence per ton, and have a high capacity for moisture, are not to be dried economically even by direct furnace heat. Mr. C. O. Bartlett says that peat with 80 per cent. moisture can be reduced to contain 5 per cent. by burning 15,000 lbs. of coal to 25 tons of peat, and it can only be dried profitably by draining and drying in the air. With mine concentrates, ores or silicate substances, only about 10 per cent. of water is held in them, and, unlike peat, they can be dried to dessication without danger of burning by rotating cylinders and direct furnace heat passed through the materials. He states that coal must be thoroughly dry before it can be satisfactorily ground, but he believes that ultimately in all large and medium-sized plants coal will be burned only in the dust form.

It is certain that for mere perfect combustion this is the proper way to burn coal, but it cannot be employed for steam boiler work until satisfactory means of dust stopping are employed with it.

Coal, with only 1 per cent. of moisture, will be ground at twice the rate of coal containing 2 per cent. Hence the importance of drying before grinding, and it is stated that coal may be delivered as hot as 150° F. from the dryer without loss of gas. It is dangerous to dry coal by passing the direct furnace products through it. Fan-propelled hot air, and a settling chamber to take out the dust, seem to be the approved method of coal drying, the settling chamber having a bottom inclined at 45° to drop the dust to a screw conveyor. Not more than 6 to 8 lbs. of moisture can be taken out of coal by each pound of fuel burned for drying purposes. Thus, even with coal, quite a large percentage must be burned in order to dry it for grinding, and if dust coal is to be used, it should be possible, one would think, to dry it by the waste gases, and necessary to burn it so as to give a considerably better efficiency to pay for grinding and drying. When dry, it ought to produce better evaporation than when fired wet, so that all the cost of drying is not lost.

If it is so costly to dry materials which are already apparently dry by the direct heat of fuel passed through the materials, how entirely out of the range of practical processes must be the employment of that small proportion of heat produced by costly steam or gas plant and conveyed electrically!

It appears that coal which contains its ash in the form of silica will dry much more readily than coal which contains an aluminous or calcareous ash.

## SINGLE-PHASE MOTORS FOR TRACTION.*

By Dr. GIORGIO FINZI.

(*Concluded from page* 730.)

The single-phase traction motor designed by the author was first of all accurately tested in the testing room of the Gadda Brioschi Finzi shop. From the results, the characteristic curves of the motor were drawn (Diagrams I. and II.). Diagram I. shows for each voltage applied, the amperes in function of the angular speed (full lines) and of the torque (dotted lines).

In our case the curves allow the clear statement that for a given torque the current is slightly higher with a higher voltage, and this more clearly when the torque is greater.

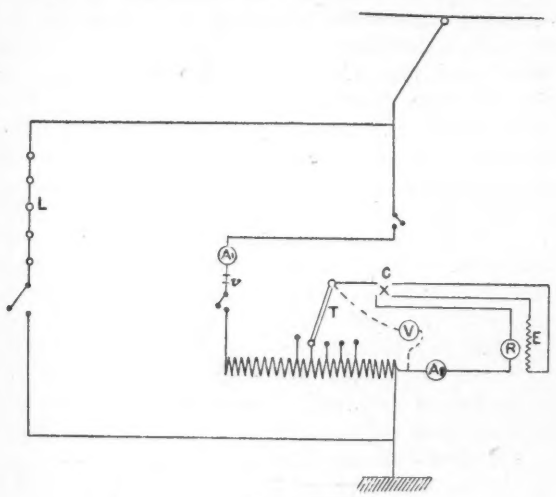



Fig. 1.

Thus we have a number of slightly divergent torque-current curves.

Diagram II. gives the efficiency and the power factor for this particular motor for various voltages in function of the speed. It is interesting to note that in the efficiency curves

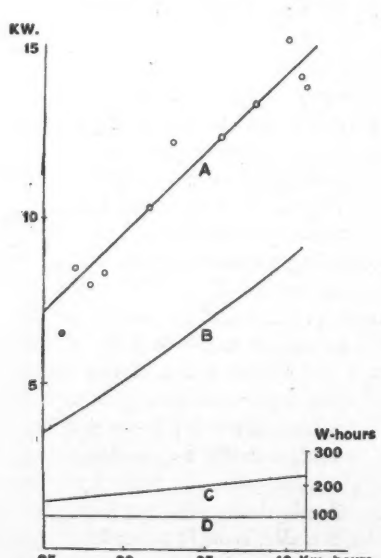



Fig. 2.

the higher segment corresponds to lower speeds when the voltage is lower, so that even though the efficiencies be not particularly high, the motor always works under favourable conditions, its speed being generally lower when the voltage is kept lower. We may also draw attention to the high value of the power factor whenever the speed is above the lowest figures.

This motor was geared to one of the ordinary cars used by the Edison Co. for City service; we took away the continuous current motor (0·7 ton), *one* controller (0·072 ton), and the rheostats (0·08 ton). Given 6·7 tons for the fully-equipped car, the stripped car weighed 5·85 tons. We put on the single-phase motor (0·8 ton) and the controlling transformer (0·5 ton); so we arrived at 7·15 tons. Let us observe that to save time a standard 40-kw. transformer was used for controlling, while a 14-kw. one is sufficient, with a weight of 0·25 ton, giving a total weight of 6·85 tons for the fully equipped car.

The circuits on the car are seen in fig. 1. The line from the trolley has a switch, I, on one platform, then it passes to the other where the controller is placed, and passes an ammeter, $A_1$, a snap-fuse, *v*, another switch, and then the auto-transformer; the other end of this is earthed, and so is one brush of the motor, R. The other brush goes to the field, E, and then to the handle of a controller, T, which takes current from different points of the transformer winding. These points go to five sections, corresponding to 80, 100, 120, 140 volts, given a 500-volt supply, and the passing of

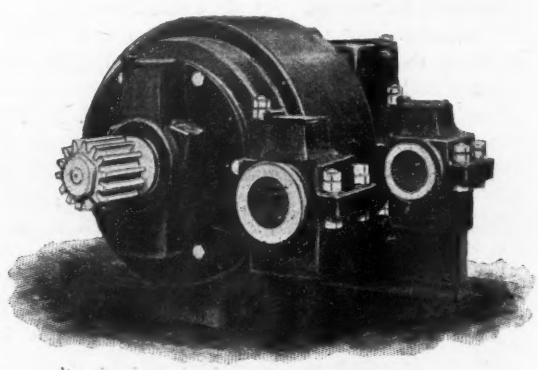


Fig. 3.—Finzi Single-phase Traction Motor.

the five points was successfully made absolutely non-sparking. It will be seen that the five points were running points; for stopping, either of the two switches was opened.

This was only for simplicity's sake, because we generally made use of already existent pieces of apparatus; of course, the controller as designed for practice has a dead section for stopping. Through a switch C the fields were reversed to run in the opposite direction; an ammeter $A_2$ showed the current in the motor, and a voltmeter V the voltage. All testing instruments in the car were of the hot-wire pattern.

A special circuit wired as usual from trolley to earth carried the incandescent lamps, L, of the car.

The usual way of gearing the motor was adopted, a standard pinion (14 teeth), geared to a 67-teeth wheel (4·78 ratio). The diameter of the car wheels was 77 cm. A Kapp accelerimeter was fixed on the car, while for measuring the speed several methods were used, the ultimate and most exact one being to get it indirectly from current and voltage through the well attested curves of the motor itself.

The generating station was near the laboratory in the Edison Co.'s works at Porta Volta, and contained a 60-h.p. 3,600-v. three-phase induction motor belted to an old eight-pole alternator with rotating armature, that gave a frequency of 18 at 270 revolutions.

The exciter was one of the very old and curious Edison dynamos with thin upright fields.

The voltage of the alternator was raised from 90 volts to about 550 by an auto-transformer, feeding the trolley line through the laboratory, the other wire being connected to the rails. The instruments were a hot wire ammeter, a Thomson integrating wattmeter, and a Siemens wattmeter, which was replaced after some nights by one of the excellent recording wattmeters (Olivetti's) specially arranged for our experiments. Another voltmeter showed the line voltage; this varied from 575 volts on open circuit to about 520 volts when the car was running.

* Paper read before the Annual Convention of the Associazione Elettrotecnica Italiana at Naples, October 11th and 12th, 1903.

The greatest number of runs was made during the night on the municipal line connecting the Monumental Cemetery with the new Musocco Cemetery; when the ordinary traffic was stopped the Musocco and the Cagnola sections were disconnected from the continuous current system and the alternate current was fed in. The track had Vignoles rails for its whole length—about 5 km.—with a considerable number of switches and several curves of small radius; the crossing over the ordinary circle railway has an average 2·5 per cent. grade for 225 metres on each side. Besides, the whole line has an average grade of 2 per cent. from Musocco to the Monumental Cemetery.

The test runs began on June 29th, 1903, continuing for ten nights. The last two nights' run were made through the whole town of Milan, running on the tramcar lines (Phœnix rails) with a trailer, through Bramante-Principe Umberto Vincenzo Monti-Monforte, and nearly the whole of the outer circle. The total mileage of the car was about 200 km. Not the slightest difficulty was found from such new electric equipment; and it is remarkable that even the grade and curve of the Central Railway station were managed, though not very easily, by our car with full load and one trailer, while, owing to the drop of voltage of the generator, the motor received only 95 volts instead of 160 volts.

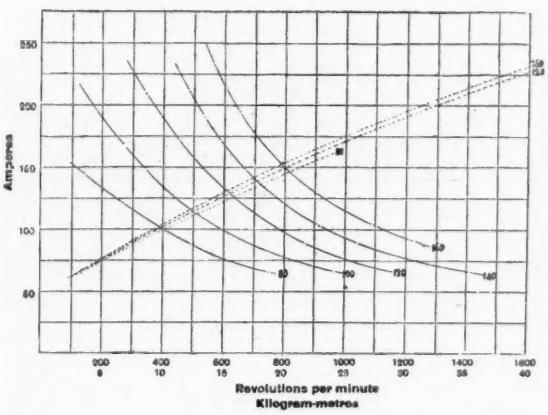



Diagram I.—Current-speed Curves, Full Lines; Current-torque Curves, Dotted Lines.

The very first tests showed very smooth speeding up, and the same absence from sparking that the laboratory tests had shown, this satisfactory commutation being chiefly apparent in starting, when the motor in every way behaves *better* than the corresponding continuous current traction motor. Some little sparking occurs from time to time, only when the full voltage is fed; not more, however, than is usually observed in a good standard traction motor. The infrequent sparks did not show the colour or the light of an arc, resembling rather carbon particles worn away from the brushes. As a matter of fact, the 200 km. left the commutator perfectly clean and smooth, with the same appearance as it showed before, and the brushes showed no measurable wear.

The car was lighted with the same lamps that were on the ordinary 500-volt circuit—six incandescent lamps in series. Our slightly higher alternating voltage made them burn more brightly than usual, and the fluctuations of the pressure were not much felt; they would disappear altogether by the use of standard lamps of 50 volts or less, instead of our 100-volt ones.

The object of the tests was, on one side to determine the general working of the motor in regard to its specific qualities for traction use, on the other, to measure how much power the runs and the startings absorb, in comparison with standard continuous current equipments. With these objects the runs have been of two different classes; some were occupied with simultaneous readings of the instruments, and together with the diagrams from the Olivetti wattmeter gave the power necessary to keep up the various speeds when once attained. These runs had very few startings—in fact, only those that were necessary.

Other runs were full of successive speeding up and stopping; thus did we gather an exact idea of what a standard starting was, while the figure from the integrating wattmeter at the end of the run showed the difference due to a given number of startings in comparison with the energy absorbed by a run without startings. The same course was carefully followed, using another car equipped with a four-turn standard G.E. 52 motor.

Our results do not claim a very high degree of accuracy, in fact, no traction experiments can, owing to the difficulty of getting exact readings at the same moment, and to the complex elements of the experiment; they are, however, trustworthy so far as they go, and some results when arrived at through different paths, show satisfactory concordance.

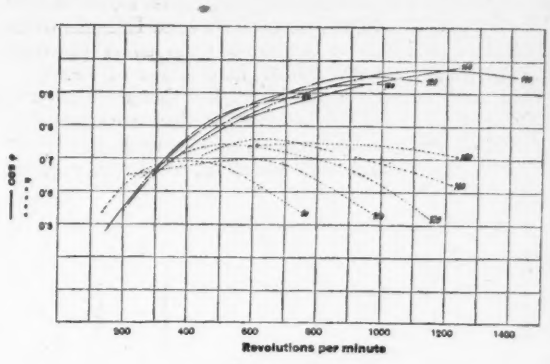



Diagram II.

In fig. 2 the line A shows the power at the generating station that is necessary for a 10-ton single-phase car, on a level straight track, at speeds between 25 and 40 km. per hour. This curve is averaged from all our experiments, and is the collective result of the Siemens wattmeter readings at measured speeds and of the Olivetti diagrams. The experimental points are rather dispersed, but not more than we anticipated from having a track with many grades and with short straight segments where a constant speed could only be kept up a short time.

The B line shows the power given by the motor, and is obtained from A, taking account of the line loss, the transformer loss, and the efficiency of the motor (given the voltage and the speed).

The line C gives the energy in watt-hours per 10-ton car-km. given by the motor; line D gives the energy dissipated per car-km. in mechanical friction, that is, after subtracting the air resistance. This last was computed considering the shape of the car and taking advantage of the coefficients found in the latest experiments (Finzi and Soldati on air resistance). Thus we find that mechanical friction absorbs 10 watt-hours per ton-km., of which about 0·5 is gear-friction;

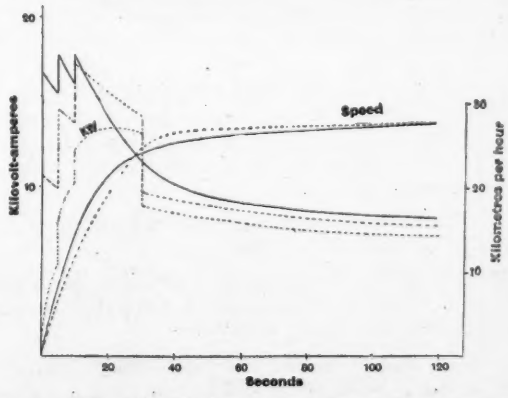



Diagram III.—G.E. 52 Motor, Full Lines; Single-phase Motor, Dotted Lines; 7·78 tons in each case.

this leads to a traction coefficient of 3·48 kg. per ton, a very normal figure for a level straight track and for Vignoles rails.

Diagram III. allows a comparison to be made between a single-

phase motor acceleration and a continuous current motor acceleration; we mean here not one individual acceleration, but—so to speak—a standard acceleration, or the composite result from various experiments, made some in one, some in the opposite direction to eliminate the influence of the average 2 per cent. grade.

We admit that on a town tramway system a maximum speed of 22 km. per hour is necessary between successive stops to get an average speed of 17 km. per hour; and the comparison is made on this basis, with almost the same acceleration for the two test-cars; we thus attained a speed of 22 km. per hour on an average acceleration of 0·25 m. per second per second with the single-phase motor, of 0·28 with the G.E. 52. The full lines of Diagram III. refer to the latter, the dotted lines to the former; the power absorbed, and the speeds, are represented in function of the time. But for the single-phase the higher line shows volt-amperes at the motor, and for the lower one we had recourse to the characteristic curves of our motor, in order to obtain the KW. line from the voltage and power factor of every point.

We can, on the other hand, compare the following data, taken from those experiments where the average speed was about the same, but where the number of accelerations was different:—

| Distance, km. | Weight, Tons. | Average speed. | Max. speed. | No. of starts per km.* | Watt-hours per ton km. | Watt-hours per start per ton. |
|---|---|---|---|---|---|---|
| 23·6 | 7·78 | 21 | 25 | 1·02 | 43·1 | } 11 } 11·6 |
| 10 | 9·05 | 20 | 22 | 0·33 | 33·2 | |
| 10 | 9·45 | 23·5 | 25 | 0·26 | 32·6 | |
| 20 | 8·21 | 17 | 21 | 1·35 | 37·2 | } 10 |
| 10 | 7·78 | 17·4 | 22 | 2·03 | 43·2 | |

* The number of accelerations was computed, taking into account the slowing down and assuming 3 slowing downs to be = to 1 stopping.

These last figures have no great value *per se*, because a small error in measuring the maximum speed between two stops is enough to vary the results appreciably—however, they coincide well enough with the figures as obtained from the

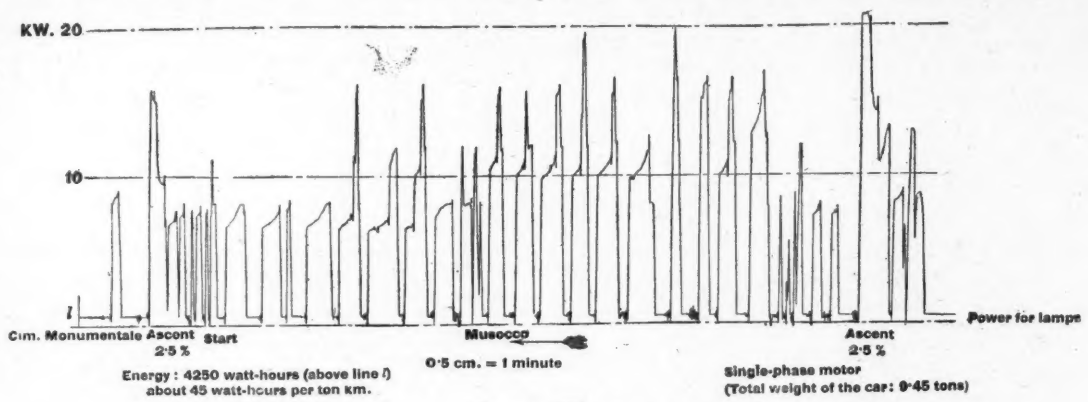



Diagram IV.

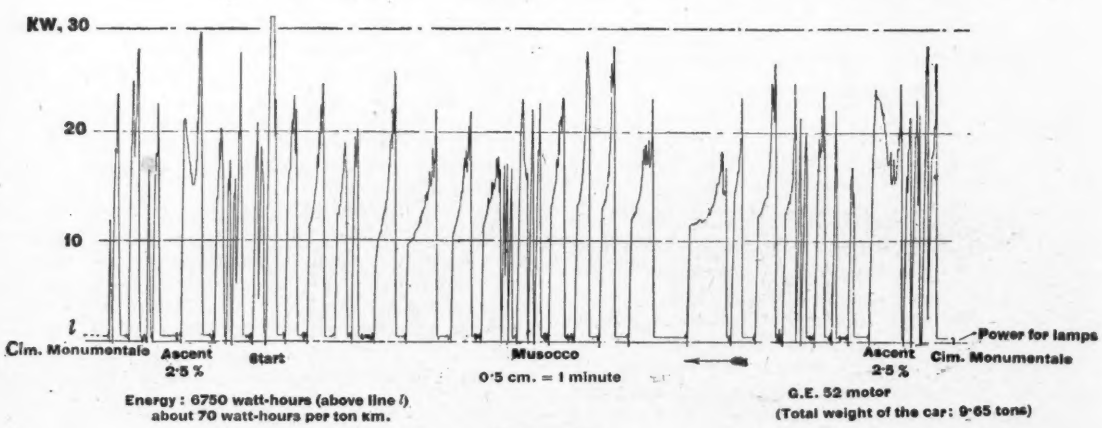



Diagram V.

Even after the starting, we find a lower absorbed power for the single-phase (though its efficiency be a trifle lower) on account of the resistances the G.E. 52 still has in series with it. When we integrate the power curves for each motor to a 22-km. speed, we find:—

For the single-phase, 9·4 watt-hours per ton.
„ G.E. 52 12·35 „ „

If we refer the integration to a 23·5-km. speed, which both motors attain in the same *time*, but at a slightly greater *distance* with the G.E. 52, we have:—

For the single-phase, 10·6 watt-hours per ton.
„ G.E. 52 14·85 „ „

While if from these figures we calculate down to the 22 km. speed, we have:—

For the single-phase, 9·35 watt-hours per ton.
„ G.E. 52 13·1 „ „

N.B.—The theoretical amount of energy required for starting to the 22 km. speed would be 6·6 watt-hours per ton.

diagram, if we take the line and transformer losses into account.

We call attention to the fact that our watt-hours per ton for starting with continuous current (12·2 to 13 to a 22-km. speed) are much lower than M. Blondel accepts from the examination of various accounts. M. Blondel assumes the empirical formula $V^2/30$, which would give in our case 16 watt-hours. But even our figure shows a 25 per cent. economy in favour of the single-phase—an economy not to be taken lightly; the power absorptions for starting on a city thoroughfare being 50 per cent., and sometimes as much as 65 per cent. of the whole consumption of current.

Diagrams IV. and V. are reproductions of the kilowattmeter diagrams at the generating station; they are to be read from right to left, and they all refer to one 10 km. run—Milan-Musocco and back on the same track—the same average speed (17·3 to 17·8 km. per hour), and the same number of starts (about 2·25 per km.).

It should be observed that the scale of ordinates is different in the two diagrams. The integration was performed by weighing the diagrams cut out in homogeneous cardboard.

We have :—

Diagram IV.—Single-phase (9·45 tons) 4,250 wh. (45 per ton-km.).
Diagram V.—G.E. 52 (9·65 „ ) 6,750 „ (70 „ ).

These figures need no special comment. It must, however, be observed that the difference is due, partly, to the fact that, in order to remain within the speed limits which we established (and which correspond to those of a city traffic) the continuous current motor had almost always to work with resistances in series. But even this shows the advantage presented in similar conditions by the monophase motor, which would allow a very wide range of velocities, without lowering the efficiency at normal speed.

As to the power factor, it varies between rather wide limits, according to speed and voltage, as the characteristic curves of the motor (Diagram II.) show; these curves, computed in the case of the acceleration (Diagram III.), give for such a *standard* way of starting an average power factor of 0·7. On the other hand, if we compare the wattmeter diagrams with the instantaneous current and voltage figures at the station during the run, we find an aggregate average power factor (for line, transformer, motor) of 0·8, varying between limits of 0·6 and 0·95.

## ELECTRIC PUMPING PLANT FOR DE BEERS CONSOLIDATED MINES, KIMBERLEY.

This plant, manufactured by Messrs. Mather & Platt, Ltd., Salford Iron Works, Manchester, consists of two "High Lift" centrifugal pumps direct coupled to polyphase motors.

No. 1 is a pump (size No. 6) with four chambers, to lift 1,000 gallons of water per minute against a total head of 320 ft. The pump body is of cast-iron, the buckets, guide posts, and spindle of steel. The pump is driven through a flexible coupling by a three-phase induction motor, taking power from a 50-cycle circuit at a pressure of 220 volts, and giving out 160 B.H.P. at 750 revolutions per minute under normal conditions.

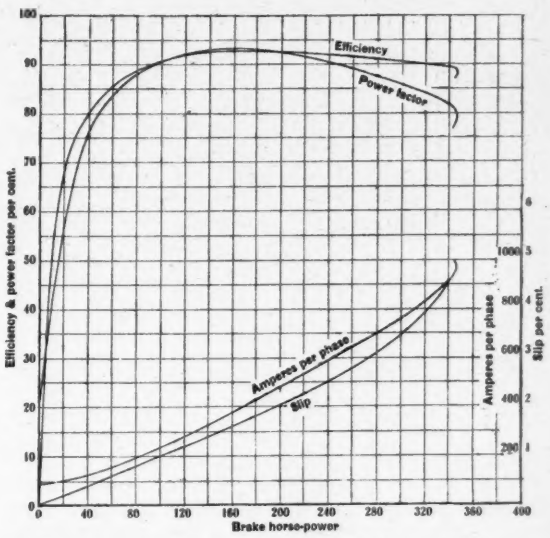
No. 2 set consists of size No. 6 two-chamber pump to lift 1,000 gallons per minute, against a total head of 160 ft., the motor, in this case, being 75 H.P. or 80 H.P., and similar to the larger set.

Both motors are started by means of a water rheostat with sheet-iron plates, which is considered the most suitable means for the working conditions.

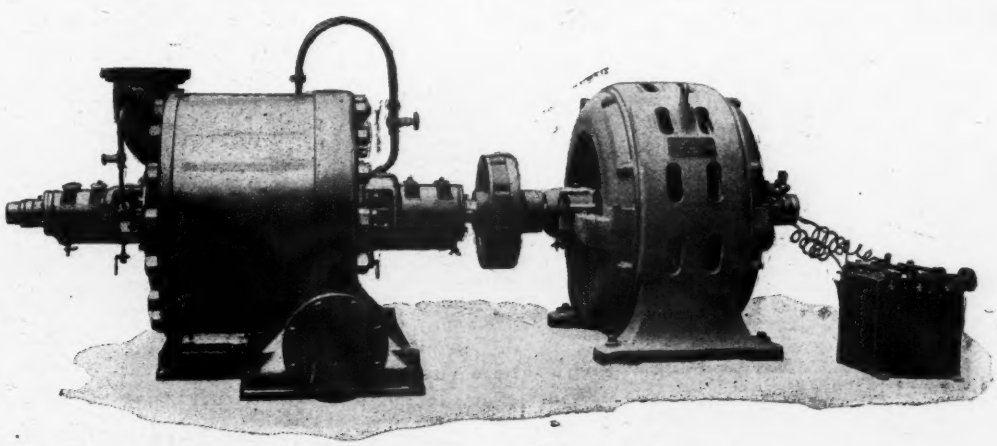
In this improved type of pump the water enters the revolving wheel axially, and in the case of single pumps symmetrically on each side of the wheel, thus eliminating axial thrust. The water then traverses the curved internal passages between the vanes, and is discharged tangentially at the periphery into a stationary guide ring ; this conveys it to the annular chamber in the body of the pump where the velocity head is converted into pressure head. From this chamber the water is discharged into the pipe line, or, in the case of multiple pumps, into the second and subsequent chambers.

The larger motor, illustrated herewith, is arranged with eight poles, giving a speed of 750 revolutions per minute when running light and a full-load speed of 735 revolutions per minute.

The stator consists of a core of soft iron laminated discs clamped in a cast-iron frame, and provided with slots on its internal periphery. The windings consist of copper bars, one in each slot, with specially formed ends which enable the number of soldered connections to be reduced to a minimum, and give a very rigid and substantial construction.




Characteristic Curves of 160-H.P. Induction Motor.



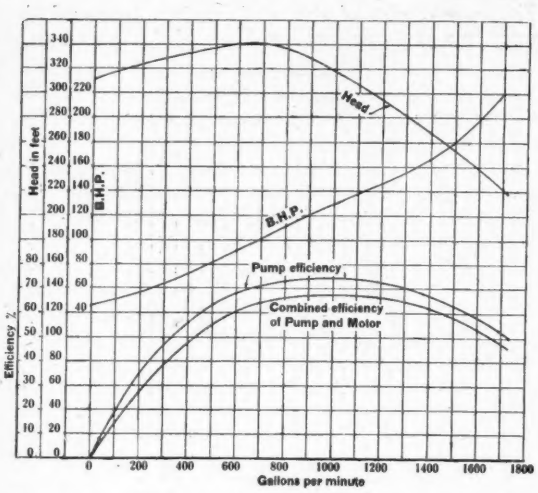
Mather & Platt Centrifugal Pump Driven by Induction Motor.

The rotor is built similarly to the stator, and is wound with formed bars carefully insulated and fixed in open slots with wooden wedges. The ends of the windings are brought to slip-rings through the shaft, which is made hollow, and alternatively to a set of switch blades, by means of which the slip-rings are short-circuited when the motor has attained full speed. Two important advantages are gained by this arrangement. In the first place, the current at starting never rises above half the normal running current, and in the second place, all loss due to brush contact and resistances of secondary cables and connections is obviated, thus giving high starting and running efficiency.

Owing to the large diameter of the motor and the small number of poles, combined with a special form of slot, an exceedingly high power factor is obtained even on comparatively light loads. The mechanical design is not sacrificed in any way to obtain this result, as the radial

clearance between stator and rotor is 2 mm., which is an ample allowance for a motor of this size.

As will be seen from the curves, the efficiency is remarkably high, and in consequence of this fact the temperature rise is extremely small, the ventilation provided being ample.




Performance of Motor-driven Pump, at 735 Revs. per Minute.

This point is of great importance in cases where motors are required to work for long periods, and in situations where the circulation of air is defective. In deep level mines the conditions in this respect are naturally adverse, and care has, therefore, to be taken to prevent overheating of the plant; a design which gives a small rise of temperature is the only satisfactory way of obviating the difficulty.

Special care is taken with these motors to get a perfect balance of the rotating parts; that this had been attained was evidenced by the total absence of vibration of the plant, which we saw started and running without holding-down bolts, on a springy foundation.

As can be seen from the curves, the motor has an overload capacity of over 100 per cent., and the mechanical design is such that this overload may safely be put on the motor for short intervals of time.

The starting current was about 160 amperes per phase, rising to 320—330 amperes at the working head of 320 ft., as shown by a Schaeffer gauge. The efficiency of the motor, as shown by the curves, is 96·5 per cent. at 120 H.P., the power factor being 93 per cent., while at more than 30 per cent. below, and 30 per cent. overload, the efficiency and power factor are over 90 per cent.

The pump efficiency at 1,000 gallons per minute is 75 per cent., and the combined efficiency of pump and motor, 67·5 per cent., and here again the efficiency is maintained throughout a range of 25 per cent. under and 25 per cent. overload, being 65 per cent. between these limits.

The temperature rise after eight hours' continuous run at full load was only 18° C.

The figures and curves for the smaller set are equally satisfactory, and the general design of both motors is simple and strong, making, with the pumps, a very serviceable and compact combination.

## DEVICES AND FITTINGS FOR THE CURRENT ELECTRIC LIGHTING SEASON.

(*Continued from page* 732.)

### Consolidated Switchboard Apparatus.

The Consolidated Electrical Co., Ltd., of Northampton Works, Canonbury, have in course of preparation a large catalogue of their manufactures. The first section, A, which is to be ready for circulation very shortly, and of which advance sheets are before us, is devoted to switchboards, fuseboards, switches, and so forth. Section B will contain particulars of electrical sundries, C will deal with circuit breakers, and D with telephonic and such like apparatus. We have now to confine ourselves to the switchboard section. The illustrations include views of switchboards supplied by the company for certain tramway power stations in the provinces, lighting switchboards for Burnley, Mexico, &c., various designs of main and distributing switch and fuseboards, many types of main switches, battery switches, and other kindred apparatus.

In fig. 5 is shown a back of board type of switch for high tension and central station work. It is the result of many requests from clients for a switch for high voltage currents where all possibility of operators receiving shocks is obviated. The only portion of the switch which appears on the face of the board is the handle, and this is completely and doubly insulated from the current-carrying portion. The various parts of the switch are fixed to the slate by means of screws in the ordinary manner, but these screws are well countersunk into the slate and the hole is filled up by an ebonite bush as shown. The switch is of the knife pattern; it is quick-break, and can be made with any length of break from 3 in. up to 24 in. if necessary, and is supplied in any size from 100 amperes to 3,000 amperes, with or without carbon breaks, and either single, double, or triple-pole. The switches are said to be specially applicable to central station work or for cases where unskilled labour is considered sufficient for switchboard attention.

Fig. 1.

Fig. 2.

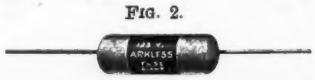


Fig. 3.

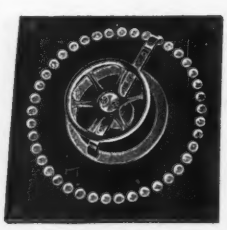


Fig. 4.

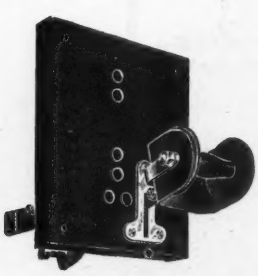


Fig. 5.

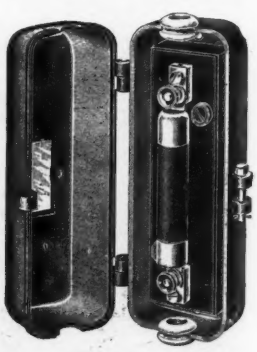


Fig. 6.—Supply Service Cut-out.

Consolidated Switchboard Apparatus.

Another of our illustrations (fig. 4) shows a circular type of regulating switch. This is suitable either for the regulation of dynamo shunts or fields, or can be used as a regulating switch for accumulators. It will be noticed that no current is carried through the pivot of the switch as a back ring is provided on which the back arm of the switch makes contact. This switch is provided with a valve handle, and is made for currents ranging from 15 to 100 amperes, in any size or for any number of stops.

Fig. 1 shows a form of double-pole double-break voltmeter plug, especially applicable for switchboard work. The sockets are fitted into the slate panel, and, with the exception of the small ebonite bush, are quite flush with the panel. The advantage claimed for this device over the ordinary voltmeter key is that the plug portion can be kept quite apart; one plug may be supplied for any number of sets of contacts, and the contacts themselves can be fixed on the switchboard at various centres so that certain plugs will only fit certain sets of contacts, thus preventing any injury to instruments with different readings. They can also be made single-pole, and for this form, of course, only two sockets and a two-pin plug are provided.

A field or shunt breaking switch is illustrated in fig. 3. It is a strong and solidly-made pattern suitable for switchboards, or for service where rough handling is likely to occur. It is provided with back connections, and is used usually in conjunction with a non-inductive resistance which is placed between the two contacts, or with an incandescent lamp of suitable voltage either in place of, or additional to, the resistance. This switch can also be made double-pole.

A new pattern of the ordinary type of supply service cut-out is shown in fig. 6. It is strongly made and is supplied suitable for voltages up to 300, and also, with longer break, for voltages up to 600. Of course, for various currents, the sizes are increased and the internal fittings are made correspondingly heavier. These cut-outs are supplied for 30, 60, 100, 200, 300 or 500 amperes. Made in the form illustrated, they may be used either for the ordinary fuse wire or for enclosed or cartridge fuses. They are made in accordance with insurance or supply companies' requirements; they are also made suitable for use with china clip or switch fuses.

The type A enclosed fuse (fig. 2) is intended to take the place of the ordinary fuse wire, and its cost is stated to be about half that of the ordinary enclosed or cartridge fuse. It consists of a fuse enclosed in a novel manner, and to either end of the fuse is attached a piece of soft copper wire. Such fuses can, therefore, be used in existing fittings where ordinary fuse wire is being used, and they are claimed to possess all the advantages of the present enclosed fuses.

### Reyrolle Switches.

The Sunbeam Lamp Co., Ltd., of Park Road, Gateshead-on-Tyne, have been appointed sole selling agents for Messrs. A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, of some of whose specialities we show a few examples. Fig. 1 shows a line of quick-break switches for main switchboard work. They are made of copper throughout, and the parts are carefully bedded all over. The blades are kept on the centre of movement by a steel ring recessed into the two

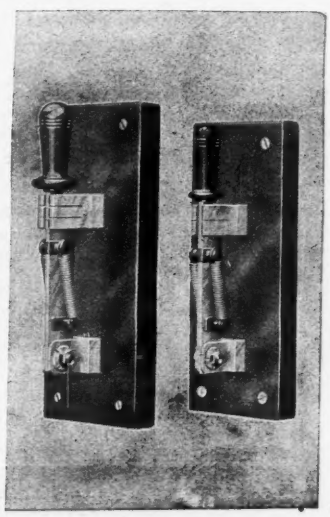


Fig. 1.—Reyrolle Single-throw Quick-break Switches.

blades; the quick-break is made by means of two phosphor bronze springs. The switches are made single, double, and triple-pole, either single or double-throw, and low resistance, with rapidity and reliability of break, are specially claimed for them. They are made for back connection, so that they fit any panel from 1 in. to 2 in. thick; the nuts and surfaces are in proportion to the current to be conveyed, and ample surface contacts are allowed.

Some tubular fuse handles for switchboard use, and for use in connection with the Reyrolle distributing panels and boxes, are illustrated in fig. 2. The fuse consists of a tubular porcelain handle fitted with brass contact pieces to carry the current. The fuse wire

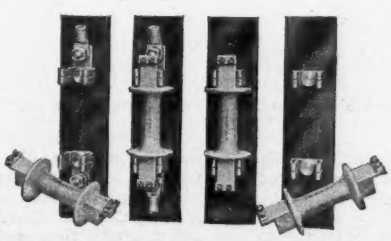


Fig. 2.—Reyrolle Tubular Fuse Handles.

is clamped between the contact part and a loose brass liner by means of two screws. The copper clip springs form part of the pillars which carry the current, and the contact surfaces are ample both on the fuse handle and on the contact clips. It is claimed that the fuse will clear itself satisfactorily even on short circuits. The clips, with terminal fittings, are made for either front or back connections. The fuse is also supplied mounted on a slate panel.

Fig. 3 shows the Reyrolle distributing panels (AA type). The fittings, which are mounted on a black enamelled slate slab, comprise a bus-bar, to which connections may be made either at the back or the front of the panel. From this bus-bar leads are run to two fuses of the clip type arranged in parallel, which fuses are each in turn connected to a tumbler switch. The bus-bar is provided with a cable sweating socket for the supply main, and two smaller sockets for connecting up to adjacent panels. It is claimed that all of the terminals are of ample size, that the wiring is simple and readily accessible, and that any combination of panels can be built up. Other types of panels are made, of which particulars and illustrations appear in the new catalogue lately issued.

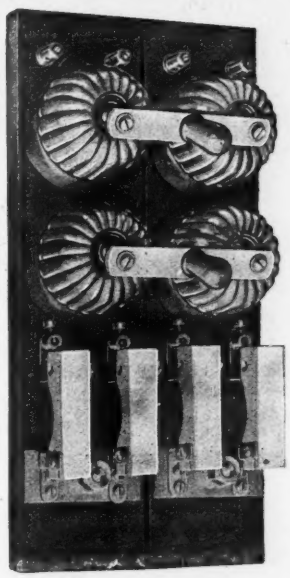


Fig. 3.—Reyrolle Distributing Panels.

The cast-iron distributing boxes made by Messrs. Reyrolle are so arranged that they may be used in unprotected positions. The shell of the box (see fig. 4) is made of a single casting, with a cast-iron door fitted with a self-locking handle, which is so arranged that the door when allowed to drop locks itself automatically. These boxes, which are made in sizes suitable for taking from two to nine

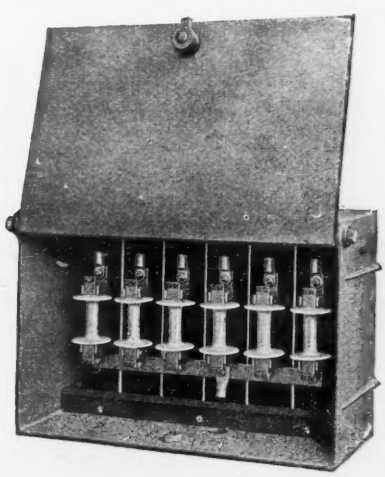


Fig. 4.—Reyrolle Distributing Box.

panels, may be fitted up as single, double, or triple-pole, insulating divisions being placed between opposite poles. The fuse and switch panels are interchangeable with one another, so that any combination can be made at will.

Two types of cast-iron dividing boxes are described in the new catalogue, and one of these we illustrate in fig. 5. It is designed for splitting a three-core high tension cable into three single cables. The boxes, which are all fitted with glands and porcelain insulators, are made suitable for all pressures up to 7,500 volts, and to take different sizes of cables by merely modifying the gun-metal ferrules at the bottom of the box. Where the cable is provided with a copper earth sheath, special arrangements are made for forming a substantial connection between this sheath and the box.

A new type of wall plug is shown in fig. 6. Type A is arranged for mounting on the wall in a vertical position, and is provided with a right angle bracket base. Type B is arranged for mounting on the wall in a horizontal position. The former type is specially suitable for outdoor use or in damp places, as it is arranged so as to be raintight. The socket is screwed so as to take a ½-in. iron gas barrel, through which the leads can be run.

These wall plugs are concentric and all live parts are highly insulated; it is claimed that they cannot be accidentally short-circuited, and that the plug, after being placed into the socket, cannot be withdrawn accidentally.

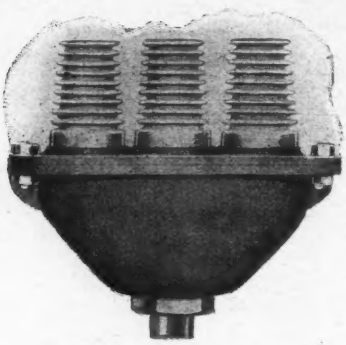
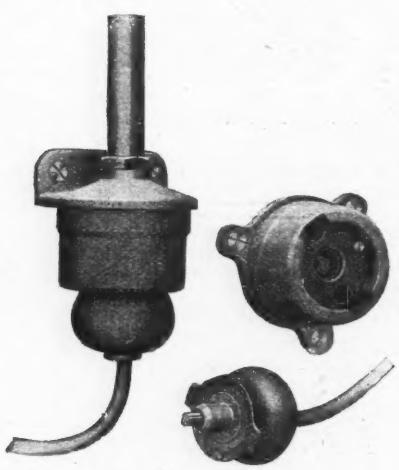


Fig. 5.—C.I. Dividing Box.

All holes through which live wires pass are bushed with insulating material, and all of the parts are standard and will fit either form of socket.

They are easily wired and mounted in position. All parts being enclosed in a cast-iron case the plugs are specially suitable for work in tramway car-sheds, and other places where they are likely to be subjected to rough usage.



Type A. Type B.

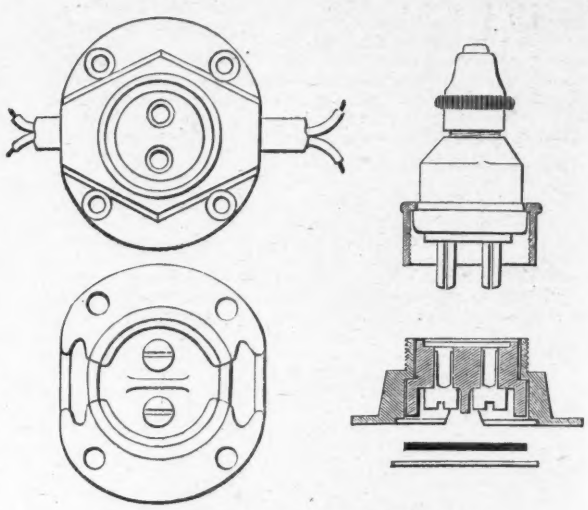
Fig. 6.—Reyrolle New Wall Plug.

In a second set of sheets Messrs. Reyrolle show some fine illustrations of their complete switchboards and switchgear equipments as supplied for three-wire continuous current lighting stations, combined lighting and traction sub-station boards, three-phase sub-station switch-gear, &c.

### Watertight Wiring System of Messrs. McAulay, Clark and McLaren.

We have before us a number of samples of joints, outlets, ceiling plates, &c., for house and mill wiring, on a system devised and patented by Messrs. McAulay, Clark & McLaren, of 10, Dixon Street, Glasgow. This, it is claimed, can be made absolutely watertight from start to finish, specially designed fuse boxes, switches, &c., being used in conjunction with lead-covered twin wire, insulated with india-rubber—a very satisfactory type of conductor for almost any kind of internal wiring. All the joint boxes are made of cast-brass, tinned at the outlets; to make a tee-joint, after the conductors have been neatly exposed and soldered, a disc of mica is laid in the joint box, the tee-joint is laid on the top of it with a mica disc between the conductors of opposite polarity, and a third mica disc is laid on top of the conductors; a close-fitting brass disc, ready tanned, is then placed over the joint in a turned recess, and the whole is soldered over, while the lead sheathing of the three outgoing leads is also sweated to the box, making the whole perfectly watertight. The lead covering is also, of course, continuous through the metal box, so that the conductors are everywhere surrounded by metal at earth potential—an important point, in view of the accidents at Fulham Baths.

One of the samples shows how a pendant is connected with a continuous conductor, the latter passing through a brass box, in the base of which is a porcelain insulator carrying two brass sockets, with slotted heads; the conductors are bared, laid in the slots, and sweated to the sockets, after which a disc of mica is laid over them and a brass disc sweated on, and the lead sheathing is also sealed to the box. The sockets referred to receive the two split pins of a plug connected with the upper end of the flexible cord, and provided with cord grips; the lampholder is attached to the other end of the flexible in the ordinary way. The plug is held securely in the ceiling plate by a screwed ferrule. The accompanying sketches illustrate this pattern. Similar fittings are made for insertion in a length of suspended cable, which is supported by a steel stranded bearer wire by copper clips, as used in mill lighting.

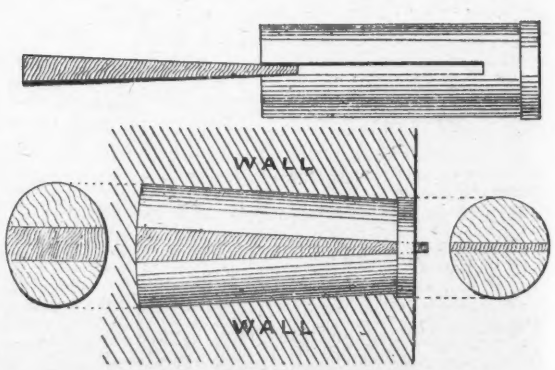


Ceiling Plate and Plug for Pendant.

Batten holder fittings for attachment to suspending wires are made, which can also be used for pendants, with the aid of a plug adapter, facilitating the removal of the pendant when desired. A handsome brass ceiling plate, with wooden patera, used in conjunction with brass fittings similar to those above described, is included amongst the samples, while cast-iron fuse boxes with sweated glands, watertight local switches, &c., are provided. The appearance of the whole shows that on this system a thoroughly substantial and waterproof installation could be carried out, both poles being insulated from earth, and enclosed in an earthed sheath throughout.

### Improved Wall Plug.

An extremely useful little device has been put on the market by the Improved Plug Company, of 54, Upper Jackson Street, Hulme, Manchester, in the form of a ready-made wall plug. This is shown by the adjoining figure, from which




Wall Plug before and after Driving.

it will be seen that the plug is fitted with a ferrule to prevent splitting, and a wedge to expand the base. Special drills are made for preparing neat holes, and the plugs are made in three sizes to stock, and other sizes as required, of hard, seasoned wood which will not shrink and work loose. Those who have experience in running casing or tubing, fixing meters, &c, will readily appreciate the saving of time and increased security which may be derived from using these plugs, instead of allowing a workman to hack a chunk of wood into a clumsy plug or "dook," often omitting the wedge, which is essential to a sound piece of work, while the plug when driven home "fits where it touches."

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**Newcastle-on-Tyne.**—A deputation will wait on the Tramways Committee respecting the price levied for the electric lighting of public buildings, which, it is contended, is too high.

## ELECTRICAL CONTRACTORS' ASSOCIATION.

In the discussion which took place last week at a crowded meeting of the above, on Mr. Rawlings's paper on a model specification for electric wiring and fitting, many of the points suggested were criticised, and others suggested.

One of the principal causes of complaint is in the expense which contractors are put to both in making up estimates, and also in travelling up and down the country to take particulars of work required to be done. Whilst some members considered that the amount ought to be allowed in the specification to cover such travelling expenses, it was recognised that so long as contractors would travel for nothing, no such allowance could be made.

As to the cost of estimating, Mr. Rawlings gave an instance of 46 firms tendering for some work at the Whitechapel Union, the total value of which was only £150. Only one of the 46 firms could get the order, so that it works out, on this basis, that one order is secured for 46 tenders, and assuming that each tender costs the firm £1, it means that he spends £46 in order to get one order. Of course, the case in question may have been exceptional.

Mr. Rawlings suggested that instead of sending in a tender in the first instance as the result of the advertisement, it might be arranged that those contractors who wished to tender should send their names in, and from these half-a-dozen should be chosen by ballot, the chosen few being then asked to tender.

Several members thought that the specification, as drawn up, was too much in favour of the contractor, and that employers would look with some suspicion on a specification drawn up by the Contractors' Association. It amounts to the same thing as a seller laying down conditions on which he will supply goods, and giving the buyer no say in the matter.

The question of jointing, casing, and tubing, was referred to by several speakers, and while some considered that jointing should be absolutely prohibited, more particularly in twin lead-covered work, others thought that the clause might be left in to provide for any case in which jointing was absolutely necessary. Tubing work came in for some little condemnation, and the question as to whether or not it should be continuous throughout its length, and not mixed up with the casing system, was also discussed. There is no doubt that much trouble arises from these mixed systems, and when the tubing is not continuous each piece should be joined to an earth wire, so that an insulation test can be made.

On the question of fittings, exception was taken to the practice which is adopted, more particularly in architects' specifications, of asking that the cost price of the fittings proposed shall be put in the schedule of prices. This leaves a contractor no margin for any work he has to do to them, and is, in our opinion, obviously unfair. One speaker took a somewhat curious view of the question, and *apparently* was of the opinion that the architect or consulting engineer pocketed the trade discount on these fittings; he suggested that it might meet the case if 5 per cent. were allowed in the contract price to cover the consulting engineer's fee. A consulting engineer, who happened to be present by invitation, protested against this, and stated that he would have absolutely no dealings with any contracting firm who recognised such practices.

In the end, a committee was appointed to go thoroughly into the question and to report to a subsequent meeting. It was proposed also that, when licked into shape, a model specification should be submitted to the Institution of Electrical Engineers for approval, so as to make it authoritative.

## CORRESPONDENCE.

### Single-Phase Alternate Current Motors.

I should like to add a few words to what Mr. Fynn has said in your issue of the 6th inst. with regard to the work done at the Central Technical College under my direction.

It is interesting to find that so many engineers were working "in parallel" with us at the College upon this subject. I can confirm Mr. Fynn's statement that three years ago a motor of 1 H.P., similar in principle to that patented by Mr. Schüler, was used by myself and Mr. Evelyn Fawssett at the College.

Like Mr. Fynn, Prof. Ayrton and I made a careful search of patents, and we also came to the conclusion that foreign publications and home patents had exhausted the possibility of protection as far as we were concerned then. I agree also entirely with Mr. Fynn's statement that sparklessness with small machines does not at all mean sparklessness with large ones, and Mr. Schüler's motors will, I think, need modification above 15 H.P. Possibly he intends to use double rotor windings, as suggested by Arnold and others. It is an open secret that Mr. Steinmetz, with the resources of the General Electric Co. behind him, has been experimenting for some years with repulsion motors, and is even now trying them on experimental tramcars. I believe that he has had no small difficulty in overcoming sparking under these conditions, if, indeed, he has yet succeeded.

I do not follow Mr. Fynn in his statement that the power factor of his repulsion motor was unity. The repulsion motor, pure and simple, is generally taken to be of the *induction motor type*, the mains which supply the power being connected to the stator windings only. I do not see how it is possible for any motor of the *induction type* to have a power factor of unity, unless (*a*) the use of condensers is admitted, or (*b*) some device similar to Heyland compensation is used, *in which case the motor ceases to be a true induction motor*.

Mr. Creedy, another student under me at the Central Technical College, has made a series of most useful theoretical investigations on this point, and I hope that he will publish his work shortly. His method shows more clearly than mine how it is that machines of the repulsion-motor type may be used for phase control, a fact which I mentioned at the British Association meeting last September.

It may not be out of place, in view of Dr. Finzi's recent article in your issue of 6th inst, to mention again that Mr. Steinmetz's diagrams for the repulsion motor in "Alternating Current Phenomena" (second and third editions), are wrong, and also that the motor which he used as an example (*ibid*) appears to be rather a poor one for the purpose.

**William Cramp.**

London, *November 9th*, 1903.

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In his letter of the 3rd inst. Mr. Fynn admits that the principal feature of my motor, viz.: The use of slip rings and a starting resistance in order to gradually change-over from the "repulsion" to the "induction" motor, is not embodied in the one he refers to. After reading Mr. Fynn's letter of the 3rd inst., it seems to me that I misunderstood the meaning of his previous letter in the ELECTRICAL REVIEW of the 23rd ult. He evidently does not claim that the features of the design of the two motors are identical, but refers only to the similarity of performance, viz.: High starting torque with low starting current, and sparkless working. I certainly do not doubt Mr. Fynn's assurance that his motor gives this performance—the same result can, no doubt, be obtained in different ways. The only question is: Which will prove the most satisfactory in practice?

With regard to the priority of my invention, I wish to say that during my own search I discovered no patent or publication for the same arrangement previous to my application for a patent. If Mr. Fynn and others have considered the same thing before, and have even tried it, without taking further steps for protecting the device after doing so, it only indicates, in my opinion, that they did not recognise the importance of the arrangement which I advocate.

**L. Schüler.**

### The Central Station Battery.

I have read with much interest the discussion that has taken place on the above subject, and would suggest that "Electrolyte" would never discover by simply looking at the cells to see if they all gas, either a cell with sulphated positive plates, or one with weak negatives, as *both* would gas up with the others at the end of charge, and it is not

uncommon to have such cells in a battery that has been working several years.

The only way to keep a battery in good condition is to obey the maker's instructions minutely, especially regarding over-charge and over-discharge.

For the detection of bad or weak cells, nothing is better than to take the voltage of each individual cell at the end of discharge, and if they are satisfactory then it is all one needs, for a central station engineer only wants his battery for discharge, and if it were possible to do without charging he would.

No doubt from the battery attendant's view, it is unnecessary to take the voltage on the end of charge, but from the engineer's view, who is in charge of the battery, and the makers, the records are indispensable as a check on the attendant, so I believe Mr. Abraham's patent recorder would be very useful and save a great deal of time. In conclusion, I disagree with "Electrolyte's" statement that it is not easy to compare specific gravity readings, because although it is well known his reasons are perfectly correct, they would affect the entire battery and not only a cell here and there, while I should imagine any person with common sense would use specific gravity readings for comparison of one cell against another, and not the whole battery readings against those of the previous week without making some allowance for altered conditions.

**H. S. Pursey.**

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Having read with great interest the accounts in your valuable paper concerning the conditions of storage batteries, with reference to Mr. Abraham's account, I have not had the opportunity of using the patent cell recorder; but as Mr. Abraham states that this saves time and current, he deserves credit for his time-saving apparatus, and it should be welcomed on the market, as it is a weary job going round the battery, especially on a cold winter's day, with paper, pencil and volt meter. I would like to state a few points that have occurred to me whilst supervising the maintenance of batteries. There are manufacturers who state that when a battery has been ruined after working a period of two or three years, it is positively ruined through neglect, which certainly is true in some cases, but there are several difficulties which could be overcome by the manufacturers themselves.

I have noticed in cells where there has been no end support between the side and the negative end plate in glass boxes, the plate has slowly worked away from its position, causing the glass separating rods to fall down to the bottom of the cell; consequently the positive plate has nothing to keep it in position beyond the supports the plate rests on. It gradually works its way to the negative, thus causing a short-circuit, which, if not discovered immediately, will buckle all the positive plates, and render them unfit for further use. I have learned from experience that plates in a battery must have end packing pieces, which are usually omitted in cases of batteries in glass boxes. I have also noticed that in cells with plates 10½ in. wide × 11 in. deep there are only two glass separating rods between the plates, the rods being about 6 in. apart. I find this space is too large, as the positive plates of a cell that has been kept in good condition have buckled either one way or the other, caused by the absence of sufficient separators to keep the plates straight, thus causing short-circuits. If three rods were placed between each two plates, the amount of buckling would be greatly diminished. There is also a fault, in my opinion, as to the cells not being deep enough, evaporation causing the cells to be filled up so often; having filled up the cells with water, this changes the specific gravity considerably, and as when the cells have been filled up with water it does not become thoroughly mixed with the electrolyte till the battery has been charged several times, the specific gravity should not be taken directly after the battery has been filled up with water. In even some large cells there is only about ¾ in. between the top of the plates and the top of the cell; this could easily be made about 2 in., which would allow the battery to run a much longer period without filling up. If the battery is to be in good condition, the cells must all start gassing at the same time; any one being backward must be cut out and examined at once, and the defect must be found. Having been found and rectified, the individual cell should be charged with a small generator kept for the purpose, which gives an amperage equal to the charging capacity of the battery, and has a field regulator to vary the voltage from 2 to 10 volts, allowing two or three cells to be charged, if necessary, at a time. There are several plants where batteries are installed omitting a small milking generator, and thus when a faulty cell is found it is put in circuit when charging and cut out when discharging. In several cases it takes the greater part of a week before the cell is fully charged, thus the attendant becomes careless and the cells neglected, whereas the small generator coupled to the cell could be left charging till the cell was completely charged.

Specific gravity and voltmeter readings are taken once a week, say this is done every Monday; but this is not sufficient for the week, as a short-circuit may occur on the Tuesday and before the following Monday the cell may be completely ruined, therefore a daily inspection must be made to determine that the cells are gassing freely, as a short-circuit will soon run down a cell and put it behind the others. This daily examination only requires about 10 minutes on a 300-cell battery. I have a battery of 450 ampere-hours which has been under my personal supervision for four years, and is almost as good as new. I put an additional row of glass separators in each cell three years ago, and thus reduced the interval from 6 in. to 3 in., which was a great improvement. I have packed between the end plates and the end of the glass boxes to keep the end plates in position, which has kept the plates in a much straighter condition, making a short-circuit a very rare occurrence. The few that have occurred have been mostly caused by paste dropping out of the plates and getting across. Batteries must not be over-discharged, though an additional charge once a week lasting a few hours will help to keep the battery in good condition.

**All Gassing.**

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### The Greatest Electric Shock on Record.

This shock was received, on August 23rd, 1903, by an Italian named Archimedi Lazzari, from Mantova, Italy. He is a strongly built man, 36 years of age, and by profession a mechanical blacksmith, in which capacity he worked during the whole of the construction work for the Canadian-American hydraulic plant at Parnahyba, State of Sao Paulo, Brazil.

This company supplies electricity for tramways, light and power in the City of Sao Paulo, which is 33 kilometres away from the generating station at Parnahyba. The station contains four 1,000-KW., 252 amperes, 2,300-volt, 60-cycle alternators, of the New York General Electric Co.'s make. The voltage is raised by means of transformers up to 24,000 volts.

A little before the date mentioned, the management decided to change all the iron framework behind the high-tension board to wooden work. It was also found advisable, as additional panels had just been erected, to change over the position of some of the old panels in order to symmetrize the board, thus permitting the high-tension buses to be divided into halves, by means of switches, to facilitate cleaning.

Everything being in readiness at 12 o'clock midnight, on Sunday, August 23rd, the work was commenced, this being the hour of lightest load. Archimedi was working in his professional capacity. At about 5.10 a.m., the ironwork had been removed and the wooden framing placed in position. The buses had also been divided into halves preparatory to being connected to their respective switches. There are two separate sets of bus-bars, one above the other, either of which can carry the entire load, so that as the work proceeded the current was changed alternately from one set to the other, thus avoiding the necessity of working on live wires. Every precaution had been taken against accidents, and, in fact, it was over-zeal to be cautious which caused the mishap. The buses being divided, and the work being carried on upon the dead section, one of the operators, Thomas W. Bevan, jun., son of the power house superintendent, went over to work near the live half. Archimedi, wishing to warn him of his danger, took hold of Bevan, jun.'s wrist, and leaned forward to speak with him; at the

same time he had his foot against an anchor bolt of the iron framework which had just been taken down. This bolt was cemented on to the floor of the gallery (the high-tension board being on a gallery), the latter being made of steel rails with brickwork arching between the rails. Archimedi leaned over too far and came too near one of the 24,000-volt bare copper wires, which was one of the secondary leads off the main transformers to the high-tension board. Immediately the current jumped on to his shoulder, passing through his body and out at his feet on to the anchor bolt. Both Archimedi and Bevan, jun., remained transfixed, while Mr. Bevan, sen., thinking it was his son who was on the wire, leaped into the air (in order to disconnect himself from the ground) and plunged against his son. The shock pulled both men off the wire, and Archimedi loosened Bevan's wrist, only to fall near the wire again, in almost identically the same position as before, only this time the whole current was passing through his own body, not as before, when a portion must have been shunted through Bevan, jun. Mr. Bevan, sen., who was thrown violently on the floor, tried to kick Archimedi's foot from under him, only to find that every time he (Mr. Bevan, sen.) touched the stricken man's foot, his own legs were shot back with terrific force. Archimedi remained thus until the power was taken off. He must have been fully half a minute under the action of the current. He claims to have been conscious all the time, and says that he felt nothing. In fact, he was able to describe exactly what occurred, and says he felt the power taken off the first time, and then come on again, as he fell the second time near the wire. On the power being taken off he immediately became unconscious, and his mouth had to be opened with the end of a file, and a piece of wood put between his teeth to keep them apart, while his arms and legs were being worked so as to produce artificial respiration. In a little over 10 minutes Archimedi was able to walk about on a man's arm. He felt sick and had fearful burns on his shoulder and his foot, but after about six weeks' absence he came back to work and has not missed a day since. Both the Bevans suffered nothing greater than little burns over the body, wherever the current came in contact.

All the men present are willing to vouch as to the place in which Archimedi suffered the shock, namely, on the high-tension gallery, and there are no wires there except bare copper wires, all under a pressure of 24,000 volts.

The writer, who was present (and who at once rushed to the switchboard under the gallery and pulled out the main exciter switches), observed a heavy arc between Archimedi's foot and the anchor bolt, and Bevan, jun., saw a similar arc formed between his shoulder and the wire. There was apparently, therefore, no actual contact with the wires, and owing to the high resistance of the arcs, the current was greatly reduced in volume. This probably explains the reason why the men were not killed instantly.

**W. da F. B. Davids.**

Parnahyba,
c/o Sao Paulo Tramway, Light and Power Co., Ltd.,
Sao Paulo, Brazil.
*October 14th*, 1903.

### Automatic Ticket Issuers.

I want to know if there are any automatic ticket issuers in use on any tramway system in the United Kingdom or elsewhere, or if such were ever tried, and if so, were they a success or not?

Any information on the above will be acceptable.

**Long John.**

### Waste of Energy in Tendering.

I have read with interest the correspondence on the waste of time, energy and money which takes place in tendering, and having had considerable experience in preparing tenders and also afterwards in preparing specifications, the subject is one which has for a long time appealed to me very strongly.

Everyone will admit that the present state of affairs is very unsatisfactory, and the only question is, What is the best method of preventing it? What is the reason for it? There can be no doubt that the initial cause is the extreme competition existing between electrical contractors and electrical manufacturers, and the remedy is, to a large extent, in their own hands.

My own practice is to limit the number of competitors for any given contract to three or four firms of as nearly as possible equal standing and experience, and to award the contract to the lowest tenderer, but I almost invariably find that there are a large number of other contractors who wish to tender, and who beg hard to be allowed to have a copy of the specification, stating that, while they appreciate my desire, consistent with doing the best for my clients, to cause as little useless trouble as possible, yet they do not mind this trouble, and desire to be allowed a chance of tendering.

When the work is open to public competition, or when, for any reason, it has attracted special notice among contractors, then the number of applications for specifications is very large indeed.

Let contractors, therefore, realise that it is in their own interests that only a few specifications should be issued for any one contract, and refrain from pressing to be allowed to tender when they are already informed that a fair number of specifications have been issued.

There is another evil which might very well be considered at the same time; that is, the practice of firms trying to send in tenders after sealed tenders have already been received from other firms.

In a recent case in my own practice, after a number of sealed tenders had been received, after they had been examined and reported on by my firm, and our clients had practically decided on the selected firms, and after the lowest tenderer had been informed unofficially that although, for certain reasons, the contracts could not be given out for a week or two, there was practically no doubt that he would obtain the order, another firm heard of the work, and asked to be allowed to tender. We replied that they were too late, sealed tenders having already been received, and the work was practically given out. Notwithstanding this, they approached our clients, obtained a copy of the specification and sent in a tender, which was considerably below that first selected.

On the matter coming before us we pointed out to our clients that although neither of the firms in question had actually carried out contracts under our supervision, we believed that both of them could carry out the work perfectly well; but that under the circumstances we did not think the second tender should be considered. On the other hand, there was great force in the remark of one of our clients: "if the contractors are not loyal to each other, why should we pay a good many hundred pounds more to the firm who sent in the first tender than is asked for by the second tenderer?"

I am pleased to say that eventually the contract went to the firm originally selected, but this is, I fear, only one among many similar cases, and if the contractors were to adopt the suggestions put forward in Messrs. Duncan Watson's letter, I feel sure that all consulting engineers would be only too pleased to restrict the number of specifications issued.

If, Sir, this letter is not trespassing too much on your space, there is one more point in conclusion well worthy of consideration; that is, whether steps cannot be taken to reduce the number of samples and drawings which are asked for in connection with many specifications.

There are, of course, many cases in which it is necessary that all the competing firms should enclose drawings and samples with their tenders, but, on the other hand, there are a large number of cases where this is unnecessary. What is wanted having been described as clearly as possible in the specification, tenders can be received, and then after one or, perhaps, two firms have been provisionally selected, they can be asked to submit their drawings and samples for the engineers' final decision before placing the contract. No one can object to this when there is a reasonable probability of their getting the work, and it would avoid the very considerable, useless trouble and expense involved when these drawings and samples have to be submitted by every one of the firms competing.

**A. H. Dykes.**

London, S.W., *November 6th*, 1903.

Doubtless most of your readers have heard of a recent case where no less than 46 contractors tendered for wiring, &c., at the Whitechapel Union. Such a proceeding, apart

from any other consideration, must be injurious to the trade, and who are to blame? Certainly not the consulting engineers, for in my experience these gentlemen seldom invite more than three or four firms to tender for works under £2,000, and I for one protest against any suggestion that the consulting engineer is at fault for the present unsatisfactory system. Then, Sir, who is to blame? I regret to say that I am compelled to answer that it is the contractor himself. Any consultant will tell you that he has to refuse numbers who desire to travel long distances and to tender, even though they are informed that three or four firms have already been asked to do so; and I know of a case where a contractor who could not obtain a specification from the consultant went direct to the client, and after obtaining a specification quoted a lower price than the lowest of those whose sealed tenders had been opened weeks before. In such a case the contractor was, in my opinion, guilty of the most immoral business action possible.

The foregoing is a sample of what is being done, and is one of the evils which the National Electrical Contractors' Association is trying to straighten out.

To overcome one of the present difficulties, I would suggest that advertisements be responded to by the contractor upon some such lines as follows:—

"That, subject to not more than six firms being invited, we shall be pleased to send a tender, &c."

This would simplify matters both to contractors and consultants, and save the present waste and improve the unsatisfactory system now in force.

I have already referred to this subject in a paper which I read recently before the London Electrical Contractors' Association, and I have no doubt that the Association in question will adopt some such clause as I have indicated.

**W. R. Rawlings.**

London, *November 10th*, 1903.

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### Jointless-Section Induction Coils.

Disputes as to priority are tedious except to those interested, and I will therefore merely state that my patent relates to the winding, in a practical manner, by a machine shown in the drawing, of *fine* wire only. No. 36 is the size mentioned. The Swiss patent referred to by Mr. Isenthal is that of F. Klingelfuss, of Basle. It gives no details whatever of the means employed to wind the jointless sections shown in the drawing, but the size of the wire shown is about equal to No. 14. With a few yards of fuse wire, and the aid of my fingers, I could reproduce the winding in as many minutes as it took months to carry out my plan, in which each turn of fine wire is fixed on to the surface of an insulating disc with a little hot paraffin, afterwards mostly removed by heat and pressure. Any priority in the *idea* of jointless single-wire winding seems to me out of question. Dozens of people have tried and failed years ago, myself among the number. It must not be supposed from this that I wish to withhold from Herr Klingelfuss due credit. His scientific papers on coils are of the very highest merit, but for commercial reasons he has chosen to keep all details of his actual winding machine, and, in fact, the whole matter, so far as possible, a secret. The other winding referred to is widely different from mine.

The chief gain in my winding is the improved insulation that results. Each wire is slightly separated from its neighbour, and the whole can be compressed into a solid block.

Old or not, the winding can be carried out so as to give a 10 to 12-in. spark with a secondary resistance of 4,500 ohms, and, from the stir it is making, it seems likely to revolutionise the construction of the best induction coils and cheap non-inductive resistances.

**Leslie Miller.**

London, *November 10th*, 1903.

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I beg to add a few remarks on the matter of "jointless winding and single-wire sectional winding of induction coils." I have been constantly engaged in this branch of electrical work since 1865.

In the Electrical Review of October 16th, there appears (p. 619) a description of a method of winding represented as "new." In 1868 I made a single-wire section coil with No. 30 wire for the late H. C. Baines, of Pembroke College, Oxford, and as the special tools for such thin sections were specially made for the coil (a 10-in.), I kept them, and have occasionally used them since. The coil was 10 in. long × 6 in. in diameter, and made up of 650 sections. I found no special advantage in my system of single-wire sections, which are represented by the woodcut on p. 619, and there described as "new winding for induction coils." With regard to joints, permit me to say that out of many thousands extending over the period of 38 years, I have only found two or three bad joints, and quite as many places of decay in the solid wire, and there is I, therefore, submit, no objection to joints. I have, however, a system, now many years old, of introducing insulating papers between the single-wire layers, but for ordinary purposes the single-wire sections cannot be recommended for many important reasons well known to makers of coils, one of the most important being the difficulty of taking out and replacing a single-thickness section. Nevertheless, for special purposes I have made several coils in this system and wound primary coils also in single-wire vertical sections, and have the various special tools by which these windings were made.

1. As to internal breakdown in the sections, I would point out that this is very likely to occur in single-wire sections, as the single or double paper-insulating discs are necessarily thin in relation to the wire section, and the same difficulty that arises horizontally in the Rhumkorff coil is here increased in the vertical section, as the number of sections should for a 10-in. coil be 600 to 700, whereas the horizontal layers in the same coil made on Rhumkorff's system would not exceed 30. In the single-wire section system there is therefore by far the greatest loss of space, making greater bulk necessary. After carefully testing a variety of single-wire windings, for the reasons given, and other considerations well known to manufacturers, I have discontinued recommending these windings.

2. There is no increased efficiency, and any pressure to compress the windings would only tend to cut the insulating papers and rupture the insulation.

3. Low ohmic resistance of the secondary coil, beyond certain limits, is not at all desirable, as the high potential of the spark overcomes the relatively low resistance of the secondary wire with but little loss, and the fact that many of the foreign coils have been wound with uncovered iron wire proves my contention. About 1875 I made for H. G. Neaden, Esq., then of Queen's College, Oxford, a coil having secondary wire No. 20, 28 and 35 on separate bobbins (I am writing from memory), and it was found that No. 28 wire was quite the very lowest resistance that could be recommended, unless for some very special purpose. Rhumkorff and others disapproved of very low resistance secondary coils. It is incorrect to say that a very low resistance secondary coil is specially suitable for charging Leyden jars or for use in wireless telegraphy, for unless the electromotive force in the secondary of the coil is greater than that of the insulated mast, pole, or line used to transmit the waves of force to the air or ether, clearly the coil will be feeble as a sending instrument. This has been found to be the case by experts engaged in wireless telegraphy, and the length of the secondary wire has been increased, but not its diameter, and thus a low ohmic resistance of the secondary has been found undesirable. It is equally important for high frequency apparatus (medical) to preserve the high potential in coil secondaries.

4. Climatic conditions such as those of India or Egypt would be fatal to compressed sections, as the increase of temperature would soften the insulating disc, and the pressure would indent the paper, and thinning it, cause a fracture of the insulation. The inferiority of single-wire section coils has been clearly demonstrated. When the secondary has a low resistance, not only is the spark much less frequent, but it is uncertain and feeble, due, evidently, to inferior electromotive force, the turns of wire being insufficient. A coil of the best type, 10-in. spark, wound in proper sections, will light up at least six X ray tubes of similar internal resistance at one time when excited by a current of about 10 amperes, 12 volts.

I would also refer to the letter of Mr. Hadfield, page 654, October 23rd, confirming the views I have expressed.

On page 700, October 30th, are some remarks by Mr. Miller, which appear to indicate that he regards single-wire

sections as new, but on making inquiries he will find quite the reverse is the case, and an inspection of the tools used in the winding of Mr. Baines's coil, also others, will show that this system of winding was thoroughly tried in 1868 and discarded as being much more costly and generally devoid of utility.

**Alfred Apps.**

London, *November 10th*, 1903.

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### Steam Turbo-Generating Plants.

My attention has been called to a letter in your last issue from the well-known engine builders, Messrs. Belliss and Morcom, Ltd., in which figures given in my paper recently read before the Leeds Section of the Institution of Electrical Engineers are adversely criticised.

In the case of the Electric Construction-Belliss set in the Leeds Electricity Works, I gave the steam consumption per kilowatt-hour at 19·9 lbs. (the figure given to me as approximately accurate by the city electrical engineer), whereas Messrs. Belliss put it at 19·49 lbs., including boiler and steam pipe losses, which correction I accept.

Although no definite statement is actually made, yet the whole letter is cleverly drawn out to convey the impression that reciprocating engine plants are as economical as turbine plants; and complaint is made that I compare the efficiency of reciprocating engines and turbines of about equal sizes, but working under different conditions, especially with regard to superheat and vacuum.

My reply is that it is quite fair to make comparisons between the plants mentioned in my paper, because the steam consumptions given are those obtained *under actual daily working conditions*. To the plea that a particular reciprocating plant would give a better efficiency with greater superheat and better vacuum, my reply is, Why do you not then provide the greater superheat and better vacuum, and thus obtain the alleged greater economy? Are we to assume that the engineers who have these plants under their charge, or that the engineers who built them and put them down, disregard their own fame and the interests of their employers so much that they are content to waste coal and boiler power rather than improve their vacuums and raise the temperature of superheat?

Engineers who have had an extended experience with both reciprocating steam engines and steam turbines know full well that to raise the superheat over, say, 60° F. at the stop valve means with the reciprocating engine:—

1. Increase in the difficulties and risks of running.
2. Increased wear and tear, and heavy bills for upkeep and repair.
3. An expensive oil and much of it for cylinder lubrication.

In the steam turbine none of these difficulties and expenses present themselves, hence we see in actual everyday work reciprocating engines working with little or no superheat and turbines working on high superheats.

Messrs. Belliss state that with 237° F. superheat, they can reduce the steam consumption in their Leeds plant from 19·49 lbs. to under 16 lbs. per kilowatt; then why is not this desirable and valuable economy effected? I trow it is because both Messrs. Belliss know, and the city engineers know, that with such high superheat all the difficulties named above would then be at once encountered, and the extra expenses and risks thus brought about would more than counterbalance the temporary economy to be gained.

Thus, my contention that my comparisons are fair, because they are on practical lines, is a sound contention, and it applies with equal force to the comparisons drawn between the steam turbine and the Sulzer-Kolben plants named in my paper.

Again, as regards vacuums, engineers with both classes of plant know that by reason of gland and packing leakage, it is more difficult to maintain high vacuums with reciprocating engines than with turbines.

Doubtless Messrs. Belliss would like to prove that reciprocating plants are more economical than steam turbines, but the weight of evidence is against them; it is not to be expected, however, that engine builders will allow the present rapid development of the steam turbine to proceed without making some efforts to stem the tide, futile though it may be.

I repudiate Messrs. Belliss's insinuations that I am interested in booming the turbine, or that my paper contains "misleading statements"; the figures given are, to the best of my knowledge, correct, and, moreover, they are not theoretical values, as is the figure of improved economy given for the Leeds plant, but the outcome of everyday practice, which alone is the true standard upon which to found our conclusions.

With reference to the postscript, I would correct it and put it thus-wise:—

It should always be borne in mind that the cost of obtaining the high vacuum necessary for efficiency with *either reciprocating engines or* steam turbines may become a very formidable item in the majority of inland stations.

**Geo. Wilkinson.**

Harrogate, *November 10th*, 1903.

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As engineer to the Cambridge Electric Supply Co. at the time of the trials made by Prof. Ewing, F.R.S., on a 500-kw. turbo-alternator, and having myself made the original trials at Messrs. Parsons & Co.'s works on the same machine, I should like to reply to that portion of Messrs. Belliss and Morcom's letter in your issue of November 6th, dealing with these trials.

A copy of Prof. Ewing's report on his trials is before me as I write.

I am prepared to admit that the steam pressure in this case is higher by 9 lbs., and an addition of 1 per cent. to the steam consumption should be made on this ground, this being the theoretical quantity due to such a difference of pressure according to the formula of Mr. McFarlane Gray quoted in Mr. Willans's paper.

It is unfortunate that Mr. Wilkinson should have made a mistake in the figures for vacuum. He has taken the seventh line of the table "vacuum in condenser," instead of the eighth line "vacuum in turbine." The former is 27·8 in., the latter 27·5 in. [? 25·7. Eds.] The vacuum at the trials in Newcastle was in the turbine, and was 24·5 in. The difference, therefore, in favour of the Cambridge trials is 1·2 in. and not 3·3 in. Further, it is hardly correct to say that a difference of 1 in. of vacuum results in 4 per cent. increase or diminution of steam per kilowatt. This is approximately true at 27 in., but were it so over the whole scale, the consumption with atmospheric exhaust would be 70 lbs. instead of 34 lbs. From actual experiment the difference in steam consumption at 24 in. and 25 in. vacuum is 2 per cent. On this basis the Cambridge trials are to be debited with a further 2 per cent., or 3 per cent. in all.

The actual consumption at Cambridge was 25 lbs. per kilowatt, less 5 per cent. for driving the air and circulating pumps, about which there is no dispute, leaving the net figure 25 — 1·25 = 23·75 lbs. Add to this 3 per cent., or ·71 lb., and we have a total of 24·46 lbs. per kilowatt, against 24·1, the result of my own trials, or a difference of ·36 lb. and 1·47 per cent.—say 1½ per cent.

I should be surprised if any engine builders are prepared to guarantee a repeat trial on a different site within a smaller limit of error. It is, in fact, less than the usual allowance for calibration of instruments.

Prof. Ewing, on page 4 of his report, points out that no separator was in use at Cambridge; a very efficient arrangement was employed at Messrs. Parsons' works when I carried out the original trials, and, as far as it was possible, dry steam was supplied to the turbine. Most engine builders would require a larger margin than 1½ per cent. if deprived of their separator.

I quite agree that "it is regrettable that misleading statements should be made," and I am much obliged to your correspondents for enabling me to correct this one.

**John H. Barker, M.Inst.C.E., M.I.E.E.**

Loughborough,
*November 10th*, 1903.

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**Holywood Tramway.**—The proposed electric tramway to connect Belfast with Holywood would have a length of about four miles. Holywood is a rising town with large military barracks for infantry, and another barracks for cavalry and artillery is about to be built. A syndicate has the matter in hand.

## BUSINESS NOTES.

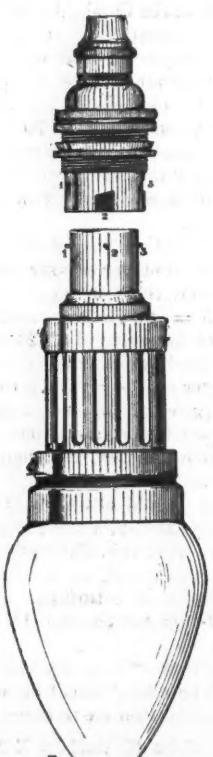
### Electrical Wares Exported.

| Week ending Nov. 11th, 1902. | | Week ending Nov. 10th, 1903. | |
|---|---|---|---|
| Adelaide | Value £88 | Alexandria | Value £909 |
| Alexandria | 140 | Amsterdam | 50 |
| Amsterdam | 40 | Antwerp | 248 |
| Bombay | 127 | Auckland | 400 |
| „ Teleg. mat. | 294 | Bangkok | 275 |
| Buenos Ayres. Teleg. mat. | 334 | Bombay | 1,168 |
| Calcutta | 684 | Brisbane | 16 |
| Cape Town | 462 | Brussels | 190 |
| „ Teleg. cable | 45 | Calcutta | 351 |
| „ Teleg. mat. | 4,607 | Cape Town | 441 |
| Durban | 181 | Chemulpo | 40 |
| „ Teleg. mat. | 6,629 | Colombo | 73 |
| East London | 302 | „ Teleg. mat. | 887 |
| Fremantle | 840 | Delagoa Bay | 357 |
| Genoa. Teleg. mat. | 112 | Durban | 1,512 |
| Gibraltar | 71 | „ Teleg. mat. | 147 |
| Hamburg | 205 | East London | 798 |
| Launceston | 27 | Flushing | 65 |
| Libau. Elec. motor | 225 | Fremantle | 32 |
| Malta. Teleg. instruments | 750 | Gibraltar | 207 |
| Melbourne | 146 | Hong Kong | 460 |
| Nagasaki | 619 | Launceston. Elec. machinery | 798 |
| „ Teleg. cable | 128 | Lyttelton | 67 |
| Perth | 79 | Melbourne | 11 |
| Port Elizabeth | 255 | Montreal | 17 |
| „ Teleg. mat. | 766 | North Sea. Teleg. cable | 1,214 |
| Rio de Janeiro | 184 | Perth | 29 |
| „ Teleg. mat. | 1,997 | Port Elizabeth | 162 |
| Shanghai | 661 | „ Teleg. mat. | 196 |
| Sydney | 650 | Rangoon | 407 |
| Teneriffe. Teleg. cable | 6,200 | Rotterdam | 30 |
| Wellington | 812 | Shanghai | 682 |
| Yokohama | 194 | Singapore | 81 |
| | | Sydney | 507 |
| | | Wellington | 301 |
| | | Yokohama | 194 |
| Total | £28,299 | Total | £12,459 |

### Foreign Goods Transhipped.

| | | | |
|---|---|---|---|
| Cape Town. El. m'ch'nry. | Value £4,000 | East London. Elec. appar. | Value £60 |
| Stockholm. Elec. appar. | 50 | Perth. Elec. machinery | 346 |
| Sydney. Elec. lamps | 48 | | |
| Total | £4,098 | Total | £406 |

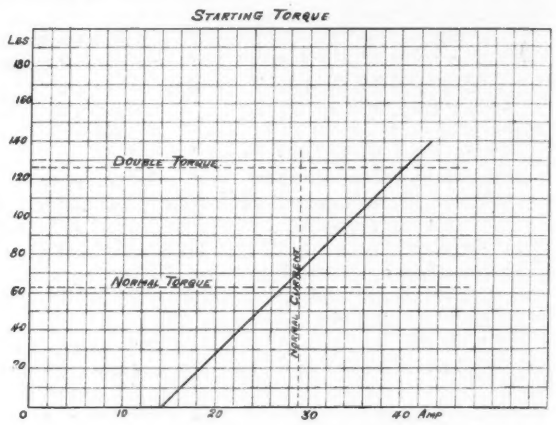
**The Nernst Lamp.**—The reason why some electrical contractors do not get on well with the Nernst lamp, while others obtain excellent results, is in the majority of cases probably due to incorrect treatment of the lamps or of their parts. The Electrical Co., Ltd, of 121—125, Charing Cross Road, W.C., who are the patentees of Nernst lamps for the United Kingdom, have carefully



Arrangement of 3-pin Holder.

investigated such cases, and have found that the two following mistakes are very common. First, the voltage of the lamp is not matched properly; the burner voltage plus the resistance voltage should be approximately equal to the *maximum* (not the *nominal*) voltage of the circuit. Secondly, with direct-current lamps, especially the B type, the polarity is not observed when the lamp is fitted in the holder, and what is even worse, the lamp is very often taken out of its holder and put back the wrong way, thus causing the polarity to be reversed and the filament to break very soon. To prevent this the Electrical Co. supplies B type Nernst lamps which have a third bayonet pin in the socket. If the holder is altered, by simply punching a third slot (as shown in the illustration), it will be impossible to put the lamp back into the holder in the wrong way. The polarity when once tested, therefore, cannot be reversed. With screw holders the reversing of the polarity is, of course, impossible, and it would be a great advantage if on large installations screw holders were used. B type lamps with screw caps can always be supplied by the Electrical Co.

**Ferranti-Schüler Single-Phase Motor.**—We recently published a description of this motor as designed for working on a circuit of frequency 50 cycles per second. We now learn that similar motors are constructed for a frequency of 100 cycles per second, on which they give satisfactory results. The accompanying curve diagram shows the performance of the motor. It will be




Starting Curve of Single-Phase Motor.

seen that the starting torque is double the normal torque, with a current about 30 per cent. above the normal full-load current; but the motor will start on the full load with less than the full-load current. These results will be regarded with keen interest; the quick success attained is certainly remarkable.

**Condensing Plant.**—The Mirrlees Watson Co., Ltd., of Scotland Street, Glasgow, have during the past few months booked the following orders for condensing plant:—

Yorkshire Power Scheme (per Babcock & Wilcox), 3 sets; Lancashire Power Scheme (ditto), 4 sets; Tokio Railways (per Dick, Kerr & Co.), 2 sets; Watson's Paper Mills (per Willans & Robinson); Wouldham Cement Co., 2 sets; Govan Corporation, 3 sets; Metropolitan Tramways (per Brush Co.), 5 sets; Clyde Valley Power Co. (per Westinghouse Co.), 2 sets; Hong Kong (per Brush Co.), 2 sets; Bromley (per Edmundson's Corporation); Bradford Corporation (per J. Musgrave & Sons); Isle of Man (per Babcock & Wilcox); British Thomson-Houston Co., Rugby, &c.

The condensing plant orders booked during the current year are to deal with over 1 million lbs. of steam, or say, 65,000 H.P., and the average H.P. dealt with per set is rather over 1,600 H.P.

**Wrinkles in Arc Lighting.**—We have often thought that the study of manufacturers' catalogues ought always to form part of the curriculum of an engineering student; and, indeed, very often much technical information can be gained in this way by engineers who are no longer in that category, though no wide-awake engineer ever leaves off learning. We are reminded of this idea by the perusal of the catalogue of the Gilbert Arc Lamp Co., of Chingford, which appears to have been arranged not merely with a view to conveying information regarding the company's productions, but also to impart a number of useful hints to users of arc lamps. For example, it is pointed out that the use of large globes should be avoided, as they possess no advantage over small ones, while the latter are cheaper and occupy less space for storage. Moreover, the small ones present a more attractive appearance when illuminated. Another note deals with the doors in lamp columns; why should these be cramped in height? There is no objection to making them 2 ft. long, giving free access to the interior; at the same time, they should be placed sideways, instead of opening on the pavement or the roadway. Referring to resistances, the compilers draw attention to the absurdly low temperature rises often stipulated for. The ultimate purpose of all heavy resistance coils is to degrade electrical energy into the form of heat, and the heat must be dissipated, an operation most readily accomplished with a high difference of temperatures. Otherwise large and costly frames are necessary, and the use of the special high resistance alloys which have been invented becomes an absurdity, for the wires have to be made of large cross-section to keep down the resistance per unit of length. Many other points are touched upon, but as those who are interested can readily obtain the original catalogue, we need not quote them further here.

**Catalogues and Lists.**—Pamphlet No. 159, issued by the British Thomson-Houston Co., describes their DA-type continuous-current generators.

Messrs. Sanders, Rehders & Co., of 108, Fenchurch Street, E.C., have brought out a new edition of their pamphlet relating to their

patent automatic $CO_2$ recorder "Ados." This apparatus, which was referred to in our columns just over a year ago at the time of the publication of the first edition, has during the past 12 months been finding considerable favour among central electricity station and other large works, as a useful method of checking combustion in boiler furnaces, and so economising in the coal bill. Several works have installed as many as five and six recorders.

Messrs. Siemens Bros. & Co., Ltd., in their price list No. 5 just issued, give some large illustrations showing clearly the principle and construction of their electrical pyrometers. Tables of resistances and temperatures (Fahrenheit and Centigrade scales respectively) are given for use with these pyrometers.

The General Electric Co., Ltd., has lately brought out several new pamphlets. One relates to electric radiators of various designs for domestic, ship, laundry and other uses. Another gives many pictures and prices of Nernst lamps for indoor and outdoor lighting, with some street and shop-window fittings which have been designed to take them. A third list gives details of the "Omega" flexible electric lighting cords.

Messrs. Charles Winn & Co., of Birmingham, have issued Section D (the third edition) of their catalogue of boiler mountings and engine fittings. Some 60 pages contain some fine illustrations of the works and of the variety of stop and safety and blow off valves, water gauge and other fittings in which the firm has long specialised.

We have received a well got up and very distinct map of the Bristol Tramways and Carriage Co.'s system, which should prove useful to visitors, &c., in Bristol.

A neat little brochure issued by Messrs. J. Sunderland & Co., of Halifax, gives illustrations of a number of private residences into which they have put electric lighting and heating installations.

An interesting illustrated catalogue has come to hand from the Cooper-Hewitt Electric Co., of New York, relating to the Hewitt mercury vapour lamp. Some photographs show the application of the lamp for lighting business offices, drawing offices, and machine shops, and a number of types for printing and photo-engraving departments, studios and other premises where excellent lighting effect is required.

The Westminster Engineering Co., Ltd., of Willesden Junction, has brought out two new price lists, (1) devoted to semi-enclosed multipolar dynamos, and (2) detailing enclosed and semi-enclosed continuous-current motors. Tables giving weights and dimensions appear.

Mr. G. Braulik, of Upper Thames Street, E.C., has just placed before the trade a new illustrated catalogue and price list of his "Braulik-Phillips" incandescent electric lamps, showing many types and shapes, including fancy reflector, tubular, tramway, and candle-flame lamps. He has also issued a trade list of the Luna Nernst lamp.

**Belliss Engine Contracts.**—The following are amongst the engine contracts lately booked by Messrs. Belliss & Morcom, Ltd., of Birmingham:—For Reigate, by the General Electric Co., Witton, one engine for coupling direct to a General Electric single-phase alternator; for Dewsbury, by Messrs. Siemens Bros. & Co., Ltd., one 500-h.p. engine for coupling direct to a Siemens generator; for North Riding Asylum, York, by Messrs. Crompton & Co., Ltd., one engine for direct coupling to a Crompton multipolar dynamo; for Gravesend, by the British Westinghouse Co., one engine for direct coupling to a Westinghouse generator.

**Cox v. Edwards.**—At the Chertsey County Court on Thursday last week, before the Hon. Arthur Russell, an electrical engineer and engine driver named Cox, residing at Hersham, sought to recover from Mr. Herbert Edwards £250 damages for injuries sustained while in his service. The plaintiff was employed to look after the engine and the electric light machinery at defendant's house, and while so engaged the driving belt flew off the wheel and knocked him down, destroying the sight of one eye. There were no guard rails or flange to the pulley of the dynamo. There was a flange on one side of the dynamo pulley, but not on the outside. After a lengthy legal argument, his Honour said he had come to the conclusion that the plaintiff was a domestic servant, and could only claim a minimum of £50. He held that he could not claim under the Employers' Liability Act. The defendant said he had had the machinery put up by a competent firm, and had no idea that it was dangerous. He denied that the defendant had ever drawn his attention to the necessity of guards being provided to protect the pulleys. His Honour said that the case against the defendant rested solely on the statement that his attention had been called to the dangerous state of the belt. He could see no evidence whatever that the defendant had failed to carry out his duty as a master to a servant, and he had employed a competent firm to put up the machinery. He gave judgment for the defendant.

**Willesden Electric Lighting.**—In our article on the arc lighting in North-west London and Willesden last week, no mention was made of the makers of the arc-lamp columns, which are, as would be gathered from the photograph, of very graceful design, unlike so many of the columns to be seen in London. They were made by Messrs. Rowland Carr & Co., of 6 and 8, Lime Street Square, London, E.C.

**German Imports of Electrical Machinery.**—There has been a large decline so far for this year in the importation of foreign electrical machinery into Germany, the returns for the eight months ending with August last showing a total of only 524 tons, as compared with 981 tons in the corresponding eight months of 1902.

**Reavell & Co., Ltd.**—The London Electric Supply Corporation has placed an order for two 40-b.h.p. compound engines, to be used for fan driving, with Messrs. Reavell & Co., Ltd., Ipswich. This firm have also obtained further orders for their well-known electrically-driven compressors, the latest order being for a 400-c.f. machine for Messrs. Vickers, Sons & Maxim's gun-mounting works. The demand for the small electrically-driven compressors for cleaning purposes in electricity stations continues, and among the latest orders which Messrs. Reavell & Co. have received are:—One compressor for the Gravesend Corporation, the order being received from the British Westinghouse Co., and an order for the Cardiff Corporation, this being placed through Messrs. Bruce Peebles & Co. Mr. Metzger recently placed an order for a second machine for sub-station work in Manchester, and the firm have also received an order for one of their quadruplex compressors from Mr. Dickinson, of the Leeds Corporation.

**The Farrell Patent Glow Lamp.**—Some time ago we mentioned that we purposed carrying out a test on this lamp, which, it is claimed, gives out twice as much candle-power in the direction of its axis as in the direction at right angles to the axis. We have now made these tests, with the following results:—

| Lamp. | Mark. | Direction. | c.p. at 100 volts. | Current, amperes. | Watts per candle. |
|---|---|---|---|---|---|
| No. 1 | 20 c.p. 100 volts | Axial | 21·3 | ·422 | 1·98 |
| | | 45° to axis | 13·0 | ·422 | 3·25 |
| | | Radial | 10·4 | ·422 | 4·05 |
| No. 2 | 16 c.p. 100 volts | Axial | 21·7 | ·455 | 2·10 |
| | | 45° to axis | 17·3 | ·455 | 2·63 |
| | | Radial | 13·6 | ·455 | 3·34 |

We may remark that the lamps have not been subjected to a life test, and, therefore, it is impossible to say whether the high candles per watt efficiencies in the direction of the axis are due to over-running or not; but the one special feature claimed for these lamps—the concentration of the light generally in the direction of the tip—is certainly substantiated by the tests. We are pleased to note that no exaggerated claims of increased spherical or hemispherical candle-power have been put forward by the inventors; confining themselves to legitimate claims, they may rely upon the approval and support of the technical Press. Obviously the practical effect of the improvement is to increase the *effective* illumination obtained from a given power expended, and this is an important consideration to the consumer.

**Trade Announcements.**—The St. Helens Cable Co., Ltd., have appointed Mr. James C. Boyd, of 33, Elm Park Avenue, Ranelagh, Dublin, as their representative for cables in Ireland.

Messrs. A. Rosenberg & Co. have purchased the business, including plant, stock and goodwill, of Mr. J. T. Mill, of 48, Myddleton Street, E.C., telegraph engineer, contractor, &c. Messrs. Rosenberg have transferred the plant and stock to their address at 21, Southampton Row, Holborn, W.C., where all inquiries should be addressed.

Owing to the name of the National Electrical Co., 32, Bachelor's Walk, Dublin, having been mistaken for that of another company of similar style, and on account of the consequent interference with business, the name was changed as from November 10th, 1903, to "Glenny & Co." The management of the business and the address of the company continue as before.

On and after November 16th, 1903, the registered address of the Oriental Telephone and Electric Co., Ltd., the Telephone Co. of Egypt, Ltd., and the China and Japan Telephone and Electric Co., Ltd., will be Alderman's House, Alderman's Walk, Bishopsgate, E.C.

The business of Mr. W. Pretty, electrical engineer, of the Osmondeston Works, Scole, Norfolk, has been taken over by a limited liability company under the style of W. Pretty & Co., Ltd.

**Books Received.**—"A Text-Book of Electrical Machinery." Vol. I. By H. J. Ryan, H. H. Norris and G. L. Hoxie. London: Chapman & Hall, Ltd.

"Liquid Fuel and its Combustion," by W. H. Booth. Westminster: Archibald Constable & Co., Ltd. 24s. net.

"Elementary Treatise on Hoisting Machinery," by Joseph Horner. London: Crosby Lockwood & Son. 7s. 6d. net.

"Telephony." (In six parts: Vol. IV.) By Arthur V. Abbott. New York: McGraw Publishing Co. 1903. $1.50 each.

"Theorie und Anwendung des Elektrischen Bogenlichtes," by H. Birrenbach. Hanover: Gebrüder Jänecke. M. 9.

"*Practical Engineer* Pocket Book, 1904," and "*Practical Engineer* Electrical Pocket Book and Diary, 1904." Manchester: The Technical Publishing Co., Ltd. 1s. and 1s. 6d. each, net.

**Dissolutions and Liquidations.**—A petition for winding-up the Electrical Publishing Co., Ltd., has been presented to the Court by Thos. W. Sheffield, an electrical engineer, of Manchester, and it is to be heard in London on November 24th.

Messrs. W. T. Drabble and S. and T. Carter (Drabble, Carter & Co., electrical engineers, West Street, Leeds), have dissolved partnership. The business will be carried on by Mr. Drabble, and he will attend to debts.

**For Sale.**—Messrs. Terson & Son will, on November 24th—26th, offer a stock of electric lighting plant and machinery for sale at Dover. See our advertisements to-day for some particulars.

Messrs. S. M. Wilkinson & Co. will, on November 24th, offer for sale by auction the electrical plant, machinery, &c., at the works of the Marquand Accumulator Co., Cardiff. Particulars are given among our advertisements to-day.

## ELECTRIC LIGHT AND POWER NOTES.

**Barcelona.**—A company has recently been formed, with a capital of 12 million pesetas, to erect a hydro-electric plant for supplying energy to the town.

**Bath.**—The U.D.C. has decided to apply to the B. of T. for a prov. order for the supply of electricity in the district.

**Batley.**—The Local Government Board has held an inquiry into an application of the Corporation for power to borrow £5,000 for electric lighting purposes. The present loan is required for the purpose of extending the cables, &c., to various outlying portions of the borough. There was no opposition.

**Belgium.**—A large electric power transmission plant has just been completed at the iron works of Messrs. Demerbe & Co., at Jemeppes.

The Government and the Commune have agreed to light the Royal domain and park at Laeken by electricity.

The Municipal Council of Assche has decided to construct an electric power station for the lighting of the Commune.

**Bognor.**—The U.D.C. has received a letter from the National Provincial Electricity Corporation seeking support to its application for a prov. order for electric lighting. It was decided to reply that the Council was already entering into an agreement for the supply of electricity under its own order, and that under the circumstances it was not prepared to enter into any further negotiations.

**Brixham.**—The U.D.C. has received an estimate of the cost of distributing electricity over a nine-mile area. With the station and plant the expenditure came to £13,540, the cost of generation, payment of interest, &c., was placed at £1,248; the sale of 45,000 units at 5½d., at £1,030, leaving a deficit of £218. The Council decided to engage an engineer to prepare plans.

**Brynmawr.**—The D.C. has appointed Messrs. Copeland and Cording, Newport, as consulting engineers, to consider a scheme for the lighting of the town by electricity.

**Caerphilly.**—It was proposed to defer the E.L. scheme for a year on the recommendation of the consulting engineer, but after discussion, a motion to canvass the area and proceed with the scheme in the event of applications being received for 1,000 lights, was carried by the chairman's casting vote.

**Caterham.**—The B. of T. has forwarded to the U.D.C. its approval of the system of electricity supply adopted.

**Chippenham.**—The T.C. has decided to apply for a prov. order to enable the Corporation to supply electricity within the town and the parishes of Chippenham Without, Langley Burrell Without, and Hardenhuish, and to carry out wiring and supply fittings. As the area includes portions of the Rural District the assent of the R.D.C. has been sought and obtained.

**Clacton-on-Sea.**—The L.G.B. has sanctioned the raising of a loan of £15,225 for electric lighting purposes, and the U.D.C. has decided to apply to the B. of T. for an extension of time in which to carry out its order.

**Clyde Valley Electric Supply Co.**—The progress of the power station at Motherwell will be considerably delayed by the accident which occurred at Motherwell on the 29th ult., when the whole of the steel superstructure was blown down during a gale.

**Dartford.**—The Committee of the St. Vincent's Industrial School has decided to have the electric light installed, with 160 lamps. The U.D.C will extend the mains to the school at a cost of £230.

**Dereham.**—The Council has decided not to support the proposal of the Southern District Electric Lighting Corporation for establishing an electrical installation in the town.

**Ealing.**—The Town Council has applied to the Local Government Board for sanction to a loan of £25,000 for electric lighting purposes. £10,286 of this sum is required for plant extensions, including new boiler, cooling tower, pumps, pipework, and water-softening plant, and the necessary buildings for them, and £6,076 for main extensions.

**Eastbourne.**—An electrical exhibition is being arranged by the Corporation to be held from December 2nd to 6th. Firms desirous of exhibiting will find a notice respecting the matter in our advertisement pages to-day.

**East Molesey.**—Before consenting to the application of Edmundson's Corporation for a prov. order, the U.D.C. will ascertain how neighbouring authorities are being dealt with as to terms.

**Edmonton.**—The D.C. is considering proposals for the working of its prov. order from Messrs. Suter & Co., the Sir Hiram Maxim Electrical and Engineering Co., the Industrial Engineering Co., and the North Metropolitan Electric Power Supply Co. The engineer has been instructed to ask the B. of T. for an extension of time for the laying of mains in the Council's area.

**Eton.**—The R.D.C. has given consent to the application of Maidenhead T.C. for a prov. order to supply electricity to Taplow and Burnham. Energy will be supplied at 6½d. per unit for lighting, and 4½d. for motive purposes.

**Farnham.**—The U.D.C. has decided to apply to the B. of T. for an extension of the prov. order for another year. A private company has given notice of its intention to apply for an order for the district.

**France.**—An electric power station to contain 60,000 H.P. is being built on the banks of the Seine. Brown-Boveri-Parsons turbo-generators of 7,500—9,000 H.P. will be put down.

The execution of the first part of this installation, that is, of four turbo-generators of about 30,000 H.P., will be carried out by the Electro-Mécanique Co.

St. Godart (Loire).—A hydro-electric power station is to be constructed on the Loire near the Vourdiat Bridge. Energy will be transmitted to St. Jodard, Neulise, St. Just-la-Pendue, Pinay, Balbigny, Nervieux, Néronde and Bussières.

**Germany.**—During 1902 the power stations of Berlin supplied 102½ million KW.-hours, or 6 millions more than in 1901. 41 million KW.-hours were consumed by the tramways; industrial establishments took nearly 25 millions; private lighting, 13,750,000. These figures are exclusive of the output of the railway power stations, &c.

**Glastonbury.**—The Corporation is applying for a prov. order for electric lighting in the district.

**Hanwell.**—The U.D.C. is applying for a prov. order, for electric lighting in its area.

**Horwich.**—The U.D.C. has appointed a deputation to wait upon the Bolton T.C. with regard to a supply of electricity. Bolton cannot supply Horwich until powers are obtained, and the Corporation suggests that the U.D.C. should apply for a prov. order, and transfer it to the T.C. on terms to be arranged.

**Hull.**—The local ratepayers' associations have resolved to send a deputation to the Electric Lighting Committee, to induce the latter to reduce the cost of energy, and to encourage the use of energy during the day by hiring out motors to small users.

**Italy.**—It is proposed to put down a plant to utilise the water-power of the River San Rocco at Firemallo (Modena) in the generation of electrical energy for lighting and power purposes.

**Leicester.**—A short circuit occurred at the electricity works on the evening of 24th ult., which had the effect of throwing the theatres and a considerable number of shops into darkness.

**Lincoln.**—The T.C. has decided to apply for a loan of £11,500 for extensions at the electricity works in connection with the electrification of the tramways. The amount is made up as follows:—Boiler, £900; additions to steam range, £150; 350-H.P. steam dynamo, £3,000; switchboard additions and connections, £120; over-compounding four dynamos and spare armature for 50-KW. machine, £335; traction switchboard £550; platform for ditto, £100; connecting-up switchboard, &c., £120; feeder cable extensions, £1,500; distributor extension, £3 225; services extension (250 consumers), meters, fuse boxes, &c., £1,500.

**Market Harborough.**—The U.D.C. has decided, with a view of adopting an electric lighting scheme, to inquire into installations at towns similar in size to Market Harborough, and to obtain expert advice.

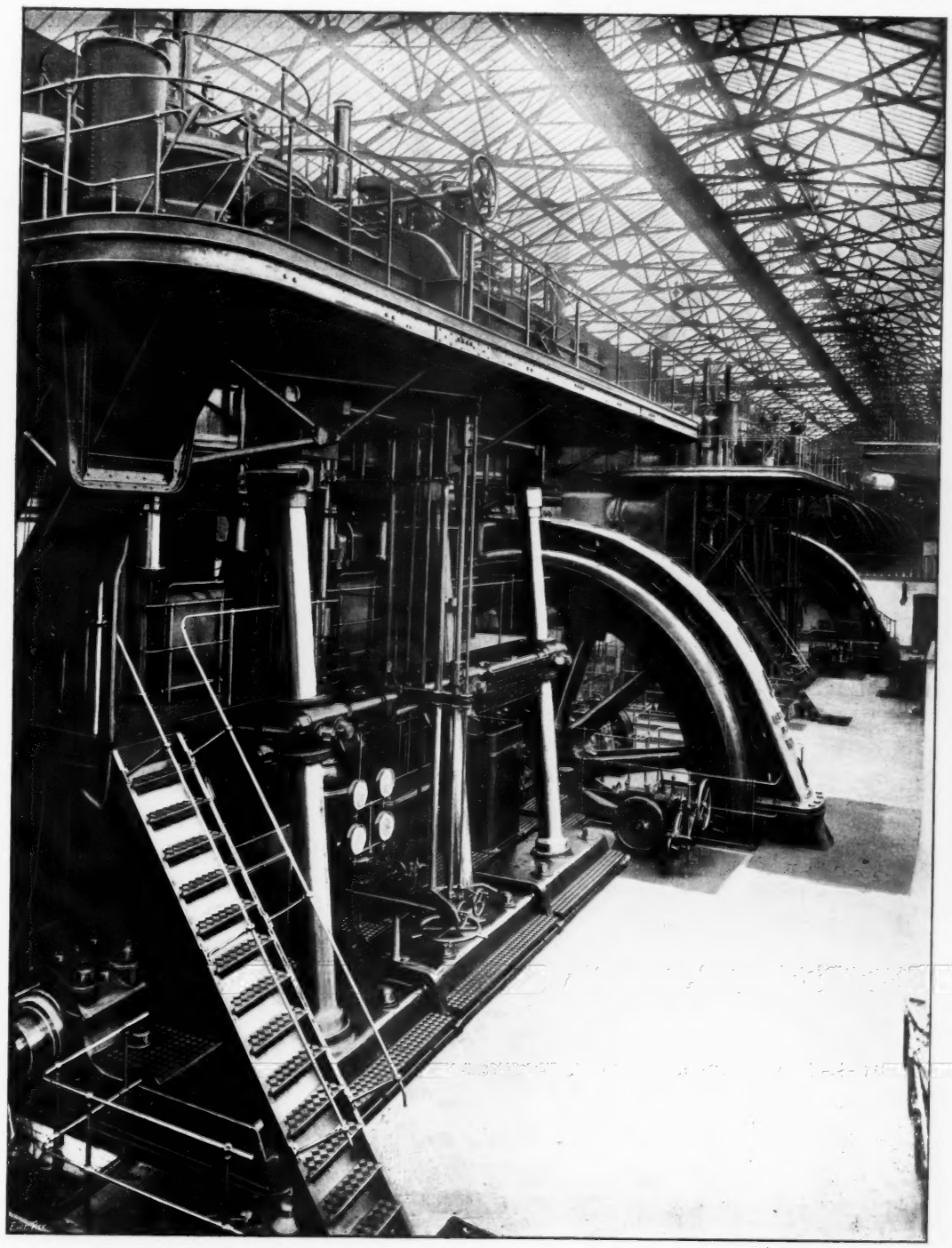
**Marlow.**—Mr. E. Ernest Smith, of 66, Victoria Street, Westminster, has approached the U.D.C. relative to the formation of a local company which will apply for a prov. order for electric lighting. His clients will find the capital, but local residents will have an opportunity of taking shares. The charges for energy will be 4d. per unit to the Council for lighting, and 2½d. for power; with 6d. and 3d. to private consumers, or an alternative scale of 7d. for the first 10 hours per quarter of maximum demand, and 3d. after to the Council for lighting, and 4d. and 2d. for power, and 7d. and 4d. and 4d. and 2½d. to ordinary consumers. A committee has been formed to consider the matter.

**Nottingham.**—The report of Mr. Mark Mellers, one of the Nottingham City auditors upon the city accounts for the half-year ended March 31st, states that the accounts of the electricity department were well kept. The cost of the opposition to the General Power Distribution Co.'s Bill amounted to £2,092 5s. 8d., which is charged upon the net revenue account, as well as £979 10s. 4d. proportion of expenses of issue of consolidated stock. After deducting £62 15s. 1d. for bad debts, there was a balance on revenue account of £31,695 14s. 7d., as against £26,840 3s. 6d. last year, out of which £6,000 was contributed to the relief of the general district rate, and £2,878 11s. 11d. transferred to the reserve fund. The balance sheet, which showed an expenditure of £408,031 16s. 8d., closed with an overdraft at the bankers of £45,527 12s. 8d. The electric tramway accounts were in admirable order. The revenue account showed a balance of £54,349 19s. 4d., from which £18,000 was contributed in aid of the general district rate, and £12,984 3s. 10d. to the reserve fund. The balance-sheet showed a gross expenditure of £555,315 0s. 11d., closing with a bank overdraft of £145,430 9s. 9d., and involving an abnormal charge for interest. The unusually large overdrafts on bankers required the careful attention of the Council.

*(Continued on page 787.)*

## RECENT DEVELOPMENTS OF THE METROPOLITAN ELECTRIC SUPPLY CO.'S INSTALLATIONS.

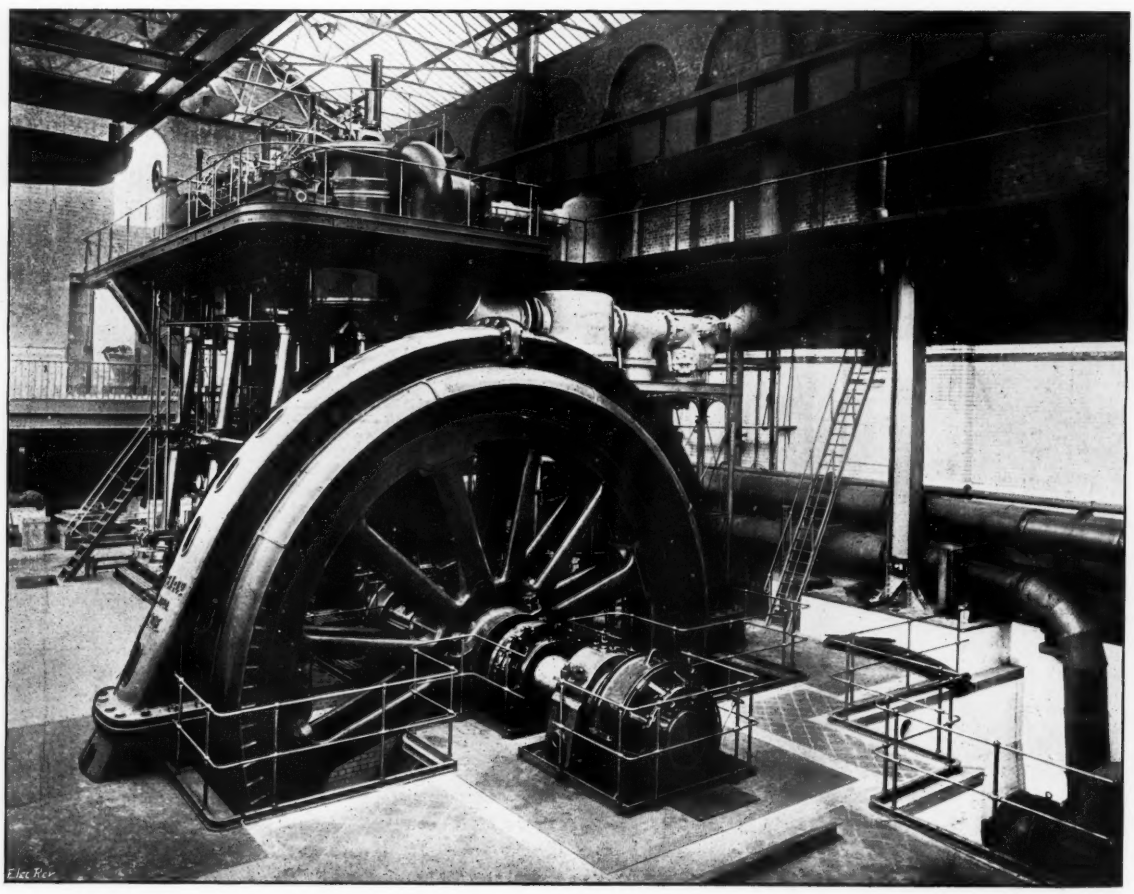
It is some time since we last put on record details of the new works laid down by the Metropolitan Electric Supply Co., Ltd. (in February, March and April, 1900); since that date great progress has been made both in the generating station at Willesden, and in the sub-stations. In the former, two 1,500-KW. Westinghouse sets, similar to those described in our articles, have been added, and two large Sulzer-Kolben sets of 3,000 KW. each, with the corresponding boilers and other accessory plant. In the latter, a large number of transformers and motor-generators have been installed for the supply of direct current to the consumers. We propose to give some particulars and illustrations of these important extensions, which we have recently been enabled to inspect by the courtesy of Mr. J. S. Highfield, chief engineer to the company. We may remark by way of preface that the undertaking is now by far the largest of those supplying electricity in the metropolis, with the sole exception of the City of London Electric Lighting Co.; these two great concerns have always run a close race for the first place in this respect, and in point of fact, while the City Co. has the larger maximum demand, the "Met." has a larger equivalent lamp connection, and a greater generating capacity, the total output of its various stations being rated at nearly 23,000 KW. Were these two undertakings combined, they



Sulzer-Kolben 3,500-kw. Steam Alternator.

would exceed in importance any other in the United Kingdom.

The most interesting additions to the plant at Willesden are, of course, the new generating sets. These are shown in the accompanying illustrations, one of which, taken from the travelling crane, at the same time forms a bird's-eye view of the whole of the existing bay, containing five 1,500-KW. and two 3,000-KW. generating sets, or 13,500 KW. in all, with a maximum of nearly 17,000 KW. The station as originally designed was deficient in height for the accommodation of the new sets, and consequently, in order to enable the crane to travel over them, it became necessary to lower the engine-room floor 10 ft., the foundations going down 21 ft. lower still, and the adjoining walls had to be underpinned. The excavations involved the removal of 8,400 tons of clay, while 4,000 tons of concrete were used for the underpinning and foundations, with 70,000 bricks.



VIEW OF 3,500-KW. KOLBEN TWO-PHASE ALTERNATOR AND EXCITER.

The whole of this work was carried out by the staff of the Metropolitan Electric Supply Co., under Mr. F. A. Knight, then resident engineer at Willesden, and to the designs and specifications of Mr. R. R. Todd, late chief engineer to the company.

The contractors for the new generating sets were Messrs. Witting, Eborall & Co., Ltd., of London. The engines were supplied by Messrs. Sulzer Bros., of Winterthur, and the generators by Messrs. Kolben & Co., of Prague, as sub-contractors; they are rated at 3,000 KW. each, with an overload capacity of 25 per cent.

The engines are of the vertical compound condensing type, to suit the boiler pressure available at Willesden, viz., 160 lbs. per sq. in.; there are two low-pressure cylinders, with one high-pressure cylinder between them, and these operate on three cranks at angles of 120°. The cylinders are 50 and 71 in. in diameter, and the stroke is 51½ in.; the engines are designed to give their full output with saturated steam supplied to the stop-valves at 150 lbs. per sq. in., and either condensing or non-condensing, at a speed of 75 revolutions per minute.

The bedplate is in three parts, weighing in all 77 tons, and bolted together through flanges. Heavy cast-iron standards, together with steel columns in front, support the cylinders, the former also carrying the crosshead guides, and galleries are provided round the whole at three levels. The columns are let into the bed-plate for a depth of 5 ft., and are stiffly braced together and to the back standards at the middle of their height. The total weight of either of the cylinders, complete, is nearly 25 tons, and the magnet wheel, which is carried at one end of the engine on an extension of the crankshaft, weighs 97 tons, giving a cyclic irregularity, as measured at full load, of 1 in 320. The whole set weighs in all 585 tons.

The crankshaft is built up of four sections, three of which form the cranks, while the fourth carries the magnet wheel; the sections are supported in two bearings each, and are joined together by flanged couplings. The shaft is of Krupp's open-hearth steel, and is pierced by a 4-in. hole throughout; the dimensions in the bearings increase from 17·8 to 25 in. diameter, and in the crank pins from 19·75 to 23·6 in., while in the hub of the fly-wheel the diameter is 31·5 in. The outer end of the shaft is carried in a self-aligning bearing on a separate sole-plate, adjustable in height; the diameter of the journal is here 21·6 in. The brasses are lined with white metal, and can be removed without raising the shaft.

The cylinders are fitted with liners of specially hard cast-iron, and are steam jacketed, heavily lagged, and covered with planished steel sheeting. The valves are carried in the cylinder heads, so that the cylinder castings are simple and are at liberty to expand uniformly when heated.

The pistons are fitted with cast-iron packing rings, and have detachable tail rods, 7 in. in diameter. The piston rods themselves are 9 in. in diameter, with the crossheads forged

on the lower ends—hence the necessity of the tail rods being detachable, to allow the piston rods to be withdrawn downwards.

The valve-gear is of Messrs. Sulzer Bros.' latest four-seated drop-valve type, giving large port area with small clearances; the valves are ground into their seats, and these into the cylinder heads. The gear is operated from a horizontal shaft, which is driven by a vertical shaft, and the latter by the main shaft, through machine-cut bronze and steel spiral gear-wheels; the latter, as well as the horizontal shaft, run in oil-baths. All the valves, except the high-pressure admission valves, are operated by eccentrics through rolling levers, which give a slow and powerful opening, followed by a quick motion to full passage, and a gentle return of the valve to its seat.

The high-pressure admission valves are operated by trip gear controlled by the governor, which is mounted upon the vertical shaft, between the limits of cut-off from 0 to 55 per cent. The maximum variation of speed between no load and full load is less than 5 per cent. The speed can be varied by hand while the engine is running, through a range of 5 per cent. up or down. An emergency governor is also provided, which closes the stop valve and destroys the vacuum on the attainment of a speed 20 per cent. in excess of the normal.

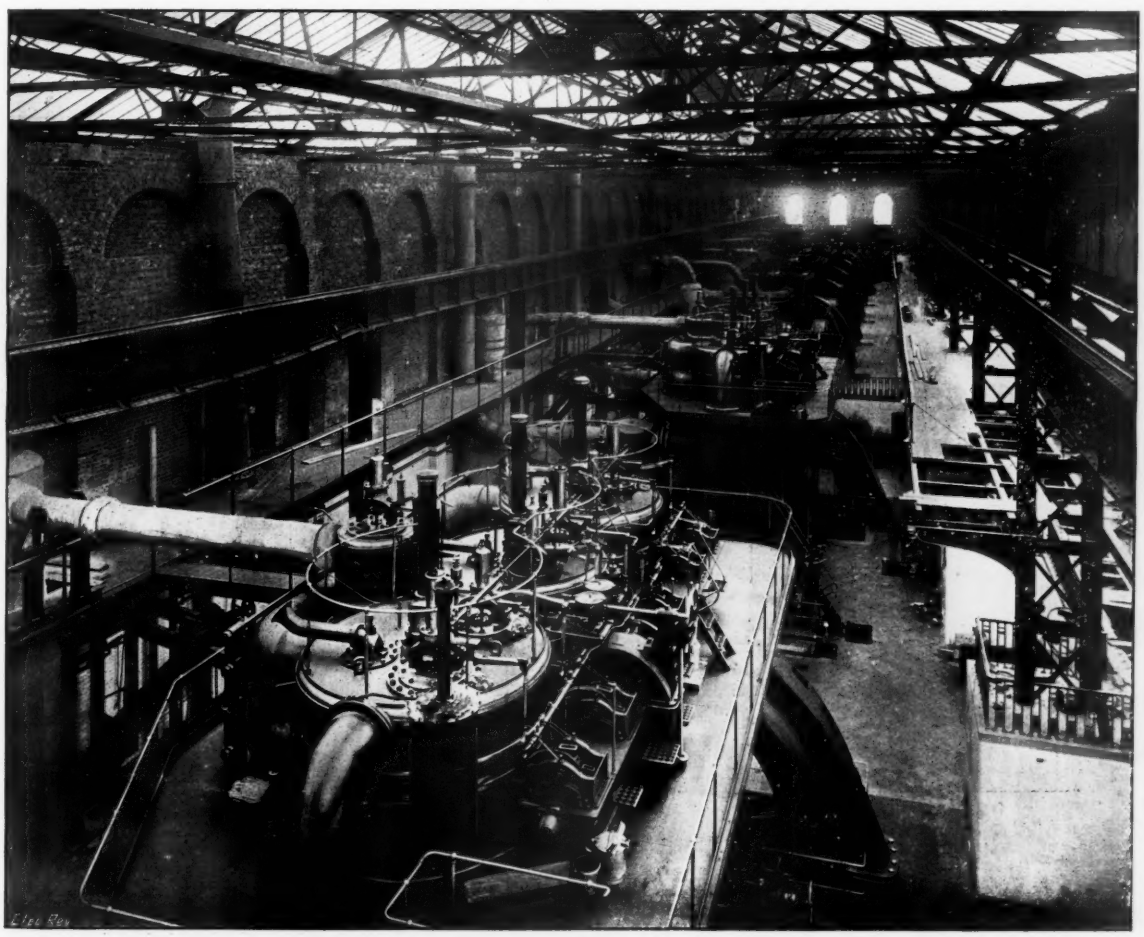
Continuous lubrication is provided to all parts by a gravitation system, the oil being automatically pumped from a tank to a reservoir on the top of the engine, whence it is distributed to the working parts; after use it is collected in the bed-plate and is returned through filters to the suction tank. Duplicate circulating pumps are provided for this purpose.

The engines are guaranteed to give the following results, with dry saturated steam at a pressure of 150 lbs. per sq. in. and a vacuum of 24 inches:—

| | Steam per I.H.P.-hour. | Mechanical efficiency, excluding air pumps, &c., at least |
|---|---|---|
| Full load ... ... | 15 lbs. | 92·5 per cent. |
| ¾ „ ... ... | 14 „ | 90 „ |
| ½ „ ... ... | 14 „ | 86 „ |

From these figures it will be seen that the maximum economy is obtained at a middle load. The consumption expected with steam superheated by 65° C. is about 1½ lbs. less in each case. At present the steam is superheated to an extent sufficient to ensure the supply of dry steam to the high pressure cylinder.

Live steam can be admitted to the low pressure cylinders to assist in carrying heavy overloads with low steam pressure, or when non-condensing; but the engines can easily carry an overload of 25 per cent. under normal conditions without this aid.



View of Engine Room from Traveller.

A steam barring engine, with automatic disengaging gear, is provided for each generating set.

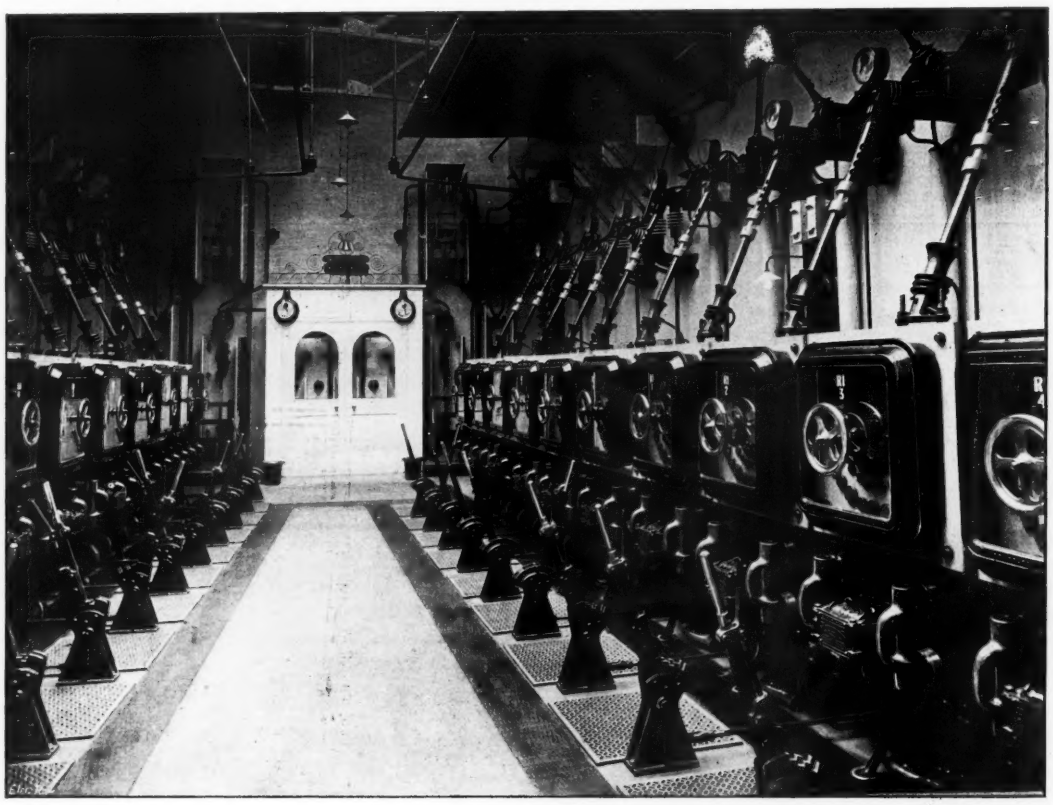
It is interesting to observe that each engine was erected complete in every respect at the makers' works, and the valve gear tested under steam, before shipment.

Separate condensing sets are provided, made by Messrs. W. H. Allen, Son & Co., of Bedford. Each of these consists of a surface condenser having a cooling surface of 11,000 sq. ft., and capable of condensing 90,000 lbs. of steam per hour, together with a three-throw Edwards air pump and a force pump, driven by steam, and two 15-in. centrifugal circulating pumps, driven by two-phase motors of 120 B.H.P., supplied by Messrs. Witting, Eborall and Co. A Holden & Brooke oil separator and grease extractor is fitted on each exhaust pipe, and a Marchant automatic exhaust valve. The circulating water is derived from and returned to the main system supplying the engine room,

which includes pipes 30 in. in diameter leading from the engine room to the cooling towers, and laid by the supply company. Two new cooling towers have been erected, each 123 ft. × 31 ft. in ground plan, and 75 ft. high, by Messrs. Donat & Co. Each of these is capable of cooling 236,250 gallons of water per hour from 150° to 80° F. The towers are made entirely of wood. The hot water enters them at a height of 26 ft. from the ground level.

The alternate current generators are of the two-phase type, with revolving fields, and are rated at 3,500 KW. each at 10,500 volts, 60 cycles per second. The generators were also specified to give 3,000 KW. each, at any voltage between 10,000 and 11,500 volts. They were guaranteed to give 3,000 KW. upon a non-inductive load at 11,000 volts, for 24 hours, with a temperature rise not exceeding 70° F.; actually, however, the temperature rise on core, applied for 20 minutes in each case. The machines are designed for continuous running night and day.

The cast-iron frame of the stationary armature is built up of four sections, bolted together and further secured by wrought-iron rings shrunk on, no auxiliary stiffening devices being required. The frame is supported at its lowest point in the pit, and is adjustable in all directions for centring; it can also be moved bodily clear of the magnet wheel by screw gear. The armature core is built up of soft sheet-steel laminations, 20 mils in thickness, insulated by paper and dove-tailed to the frame. Open slots are used, in which the winding, consisting of 10 heavily insulated copper bars enclosed in a micanite tube, is secured with boxwood wedges. The coils are former wound in the tubes, and can be removed *en bloc*, the operation of replacing a pair of coils being completely accomplished within four hours. There are three



Interior of Sub-station at Amberley Road: Berry Transformers of 2,100-kw.

trial did not exceed 45° F. under these conditions. The overload capacity was to be 25 per cent. for four hours, giving 3,750 KW., on a non-inductive load; thanks to the low temperature rise, this is easily fulfilled, and the pressure drop at constant speed and excitation does not exceed 8 per cent. between no load and overload, while under normal conditions of load the drop is less than 6½ per cent. By calculation, the pressure drop with a power factor of 85 per cent. is found to be less than 18 per cent. Had not the overall diameter of the machines been limited by the dimensions of the railway tunnels to a maximum of 30 ft., even these good results could have been improved. When the generator is running at full load on a non-inductive load, and one phase is switched out, the pressure on the other phase does not increase more than 5 per cent., and the power required for excitation at full load is less than 1 per cent. The efficiency on non-inductive loads, including excitation and air friction, is at full load 96 per cent., at ¾ load 95, and at ½ load 93 per cent.

The winding of each armature passed a test for insulation of 30,000 volts A.C. between the two phases, and 20,000 volts A.C. between either phase and the earthed armature slots per pole per phase, although the winding is two-phase.

The fly-wheel is entirely of steel, in four sections, with 12 pairs of radial arms, and is held together on the boss by bolts and shrinking rings; the boss is similarly built up, and is keyed on the shaft.

The wheel carries 96 poles of soft cast-steel, of elliptical section, with laminated pole shoes; the cores are dovetailed into the periphery of the wheel, and are bolted in place.

The poles can be slipped out sideways, complete with the windings. The latter are of copper strip wound on edge and insulated with parchment paper. The winding is pressed upon the insulated core by hydraulic power, and secured by the pole shoes and gun-metal cheeks.

The slip rings are of phosphor bronze, carried on a cast-iron spider, all these being in halves for convenience in replacement. The insulation consists of micanite and ebonite. The brushes are of carbon.

Each alternator carries its exciter on an extension of the main shaft; this machine is a 12-pole dynamo with cast-steel frame and slotted drum armature, giving 250 amperes at 150 volts.

The following are additional data of interest:—Bore of

armature core, 300 in.; diameter over field poles, 299·27 in.; air-gap, 0·315 in.; gross width of armature core, 29·1 in.; net width, 21·5 in.; depth of core, 7·2 in.; number of slots, 576; dimensions, 2·19 × 0·69 in.; conductors per slot, five in series (two in parallel); section of pole cores, 80·5 sq. in.; dimensions of pole shoes, 29·1 × 6·55 in.; turns per pole, 33.

The machines were supplied under stringent conditions as to their satisfactory performance; fines of £50 per day for late delivery, £325 per lb. of steam per kilowatt-hour in excess of the guaranteed values, and £200 per degree F. of excess temperature rise, were specified, and a heavy cash deposit was required to cover the satisfactory performance of the plant. The last-mentioned stipulation referred mainly to parallel running, it being well known that the Metropolitan Co. experienced considerable difficulties in this respect with the plant previously installed. It is satisfactory to state, however, that no such difficulty has been met with in connection with the new plant, which runs perfectly in parallel with the Westinghouse steam alternators through the step-up transformers connected with the latter.

The switch-gear supplied for the control of the new generators was made by Messrs. Ferranti, Ltd., and consists of one section for each generator, and an intermediate section comprising an interconnector panel and apparatus for controlling the main cables; the usual exciter switchgear and rheostats, synchronising gear (including an Everett-Edgcumbe dial phase indicator) and instruments are provided. The main switches are of the latest multiple oil-break type, in cast iron tanks, and the main fuses are also of the multiple oil-break type, the fuse being ¾ in. in length, and the terminals being separated by 24 in. of oil when the fuse melts. Indicating and integrating wattmeters are provided. As the switchgear has not yet received its permanent disposition, we have not included it amongst our views.

The high-pressure mains leaving the board were laid by the Supply Co., in iron troughing, under the engine room to the transformer house, where they join the 10,000-volt bus-bars.

Six dry-back boilers, by Messrs. J. Fraser & Son, of Millwall, and four Babcock & Wilcox boilers, with superheaters and chain-grate stokers, have been installed in connection with the new plant; each of these is rated at 10,000 lbs. of water evaporated per hour, but can evaporate 15,000 lbs. with ease. Additional boilers of Messrs. Babcock & Wilcox's make are now being installed.

Considerable extensions have been carried out in the transformer house, corresponding with the additions to the 500-volt Westinghouse generating plant; the arrangements are similar to those of the original installation, described in our issues of March 23rd and April 6th, 1900. New mains have also been laid along the Harrow Road, thus providing a totally independent and alternative route, in addition to the five mains of 0·2516 sq. in. cross-section laid along the bank of the canal. The new mains are three in number, each 0·5 sq. in. in cross-section—a very large size for 10,000-volt mains; they are laid in conduits, which provide ducts for two additional mains. These mains have only been in use since August last.

The fourth of our views shows the interior of the transformer sub-station at Amberley Road, adjoining the Manchester Square generating station of the Metropolitan Electric Supply Co., and the nearest to Willesden. The switch gear and other internal arrangements at this and the other sub-stations were described in our issue of April 6th, 1900, and that description still holds good in the main. The three new cables come in at the end of the room shown in our view, and end on a switchboard of marble panels, with jaw terminals which can be joined by means of coupling bars; the whole of this gear is enclosed in a locked compartment with glazed doors. The panel on the left hand is connected with the "blue" phase, that on the right with the "red," and the middle panel with the spare cable, which can be coupled up to either phase. From the same switchboard high-pressure feeders also leave the sub-station, passing on to other sub-stations, so that the feeders are practically looped in at this and most of the other sub-stations.

A similar compartment at the opposite end of the room is occupied by the terminal board of the five cables originally laid, which also are continued to the other stations, with reduced cross-section. The pilot glow lamps and voltmeters seen outside the compartment are always in action whenever the corresponding cables are alive, although, contrary perhaps to anticipation, the filaments do not give blue and red light! In some cases, however, coloured bulbs or lanterns are used which correspond with the names of the phases.

There are 21 transformers in Amberley Road sub-station, all of the Berry type, made by the British Electric Transformer Manufacturing Co., Ltd., of Hayes, Middlesex. Each of these is of 100-KW. output, and is mounted on wheels by means of which it can be drawn out of the bank into a convenient position for inspection or repairs. A regulating switch is provided on the head of each transformer, whereby the pressure on the secondary bus-bars, which work at 1,000 volts, can be varied by 120 volts in 12 steps. Intermediate steps in connection with a choking coil, seen in front of the transformer, are used exactly as in battery switches to prevent sparking at the contacts, and a glass cover prevents accidental personal contact with the live metal.

The switch-gear is, for the most part, of the type devised by Mr. G. W. Partridge, and largely used in the Metropolitan Co.'s stations; the newer switches, however, have been modified by Mr. R. R. Todd, on account of the proximity of the lower high-pressure terminal to the cast-iron bracket which carries the gear. The new pattern has two blades, neither of which at any point approaches the earthed metal work. Like the former pattern, this switch is operated by a heavy lever on the floor level.

*(To be concluded.)*

## ELECTRIC LIGHT AND POWER NOTES.

(*Continued from page* 782.)

**Northumberland.**—The work connected with the installation of the electric light at the County Asylum, at a cost of £8,496 6s. 3d., has been completed.

**Spain.**—A central electric lighting station has just been completed in the little town of Urdax (province of Navarra).

Application has been made for a concession to put down a plant to utilise the water power of the River Mijares at Montanejos (Castellon province) in the generation of electrical energy for lighting and power purposes.

**Walthamstow.**—The Lighting Committee presented the engineer's report on the supply of energy to the Higham's Park district. About 150 consumers had intimated their desire to be connected, and in the event of the scheme being decided on it would be necessary, in addition to extending the existing low-pressure mains, to run special high-tension cables from the works to a convenient point in the Higham's Park district, where a sub-station would be erected for the purpose of transforming the high-tension alternating current, which would be generated at the works, to low-tension continuous current, which would feed into the existing cable network. Having considered the proposal made by the Newton Electrical Co. to supply motors to be let out for hire in the district on the three years' purchase system, the Council to collect and forward the purchase-money to the company by quarterly instalments, the company to pay 5 per cent. to cover expenses of collection, it was recommended that the agreement with the company be approved. Consideration of the supply to Higham's Park was deferred.

**Walton-le-Dale.**—The U.D.C. is applying to the B. of T. for an electric lighting prov. order.

**West Bromwich.**—A loan of £12,217 for further extensions of the electricity plant has been applied for by the T.C. A new feeder cable is to be laid for a distance of 1¼ miles at a cost of £1,433.

**Whitby.**—The U.D.C. has applied to the L.G.B. for a loan of £2,000 for electric lighting purposes.

## ELECTRIC TRACTION NOTES.

**Adelaide (S.A.).**—The time granted to Mr. F. H. Snow for carrying out his scheme for converting the city tramways from horse to electric traction expires at the end of this year. *Australasian Hardware and Machinery* says that if Mr. Snow cannot carry out the proposal, the various companies will themselves apply for powers.

**Audenshaw.**—The U.D.C. intends applying to the B. of T. for an extension of time in which to construct and complete the electric tramways. The extension asked for is six months from December 9th next for the commencement, and one year for the completion.

**Derby.**—Preparations have been made for the immediate commencement of the work incidental to the installation of the electric trams in Derby, and a start will be made on those roads which will not be affected by the main drainage scheme. The Corporation has adopted the overhead trolley system, and the Tramways Committee has been given authority to proceed with seven routes at a cost of about £80,000. The routes to be first dealt with are from the London Road to the borough boundary at Alvaston, along the Osmaston Road to Cotton Lane, along the Normanton Road to the Normanton Hotel; thence to the Cavendish Hotel Junction on the Upper Dale Road, and along Burton Road to Vicarage Avenue. The contract for the work to be done first is in the hands of Messrs. J. G. White & Co., and the cars are being made at Loughborough.

**Huddersfield.** — The retiring mayor, Alderman F. Calvert, in his annual statement, says that the rolling stock at present consists of 70 cars, comprising 22 bogie and 48 four-wheeled or truck cars. A contract has been entered into for the conversion of 12 bogie cars into truck cars. The cars have been fitted with the Westinghouse-Newell magnetic brake, the value of which has been fully demonstrated on two or three occasions, what might otherwise have been serious accidents having been averted. All the cars have been fitted with the Hudson improved life-guard, the tray type having been condemned by the Board of Trade. A cover has been fixed over the top-deck of 27 cars. The overhead work carried out by Messrs. Macartney, McElroy & Co., Ltd., has now been taken over by the Corporation. The total traffic receipts from November 1st, 1902, to September 30th, 1903, amount to £55,863 17s. 6d., being an increase of £9,006 18s. 7d. over the corresponding period of last year. The number of passengers carried is 10,353,213—an increase of 2,927,666 over the corresponding period.

**Liverpool.**—The paragraph which appeared in the Electrical Review a fortnight ago with regard to the attitude maintained towards Mr. Thomas Utley by a number of Liverpool City Councillors seems to have borne fruit. At a meeting of the Liverpool City Council on Tuesday, when the business of appointing a Tramways Committee was before the Council, an amendment, moved by Mr. P. McGuffie, that the number of members of the Committee be increased to 19, and that Mr. Utley be added to it, gave rise to a short but sharp discussion. Finally, the amendment was carried by 62 votes to 35. Mr. Utley will accordingly have a seat on the Tramways Committee.

**Stretford.**—The Electricity and Tramways Committee have decided to include in their Parliamentary Bill, now in course of preparation, powers for the construction of additional tramways in Warwick Road, Seymour Grove and Talbot Road. If these are carried out, better travelling facilities will be given to the populous suburb of Chorlton, and readier access will be gained to the Lancashire County Cricket Ground at Old Trafford.

**Swansea.**—A meeting of the Corporation Electric Lighting and Tramways Committee was held last week when the scheme for the construction of tramways extensions to the outlying districts of Morriston, Sketty and Port Tennant was considered. The tenders received for construction were opened and considered. They numbered 30, and it was agreed to refer them to the sub-committee for classification, and the selection of three tenderers for further consideration. The firms selected will be asked to specify the extra charges for laying the electric lighting cables in trenches opened to lay the tramway cables if such should be required.

**Torquay.** — The Dolter Electric Traction Co. has abandoned the negotiations with the T.C. for a system of tramways in the town owing to the "impossible conditions" imposed by the Council.

**Vesuvius Railway.**—Messrs. Thomas Cook & Son have just constructed a new electric railway up Vesuvius from Pugliano, the northern quarter of Resina, to the terminus of the old funicular railway, which was made up the cone to the crater 23 years ago. We gather from the *Times* that this new line is nearly 4¾ miles long. "Except for a section in the middle, it is laid out with a ruling gradient of 1 in 12½, and the cars run by adhesion. In the middle portion the gradient rises to 1 in 4, an incline as great as that of the Rigi line, and in consequence it has been necessary to use a rack-rail, the Strub system having been selected, as on the Jungfrau Railway. On this rack-rail section the cars are pushed up by a four-wheel locomotive provided with two 80-H.P. motors, and fitted with an elaborate system of ordinary and emergency brakes. On the other sections the cars, which seat 24 passengers and can accommodate six more on the platforms, are propelled by their own motors, the current being supplied through overhead trollies, as is also the case for the rack-line locomotives. The generating station stands at the foot of Monte Cateroni, close to the point where the rack-rail section begins. Pugliano is already connected with Naples by electric tramway, with the exception of a short length which has still to be finished, and the old funicular line up the cone has been reconstructed and equipped for electrical working; hence it will soon be possible to travel by electricity all the way from Naples to within 250 yards of the crater a good deal more quickly and comfortably than is permitted by the present means of transport."

## TELEGRAPH AND TELEPHONE NOTES.

**Hull Telephones.**—The Corporation Telephone Committee has appointed Mr. Thos. Holme, of the Portsmouth Municipal Exchange, as manager of the telephone system, at a salary of £200 a year, increasing to £250, on a three years' agreement.

**Simultaneous Telegraphy.**—M. Petet, an inspector at Tours, has just given particulars of an application in telegraphy, of which he is the inventor. It consists of a method of utilising a trunk wire passing through two towns, as a means of communication between these towns without disturbance to the main use of the wire. Thus the Paris-Cognac wire can now be used independently of its normal use for exchange of telegrams between Tours and Châtellerault. M. Petet has also succeeded in addition in utilising the wire running from Tours-Chateaudun-Chartres for a permanent means of communication between Tours and Chateaudun and Chartres, in a manner which is equivalent to three separate wires. This installation overcomes all the difficulties which have hitherto been found insurmountable in "shared" wires, and for which the intermediate station is generally reckoned responsible.

**State-owned Telegraphs.**—The following is the official text of one of the resolutions passed at the Fifth Congress of Chambers of Commerce of the Empire, convened by the London Chamber of Commerce, and held at Montreal on August 17th to 21st, 1903, under the presidency of the Right Hon. Lord Brassey, K.C.B.:—

That, in the opinion of this Congress, all the self-governing British communities around the globe should be united by a continuous chain of State-owned telegraphs. That such an inter-Imperial line of communication would, under Government control, put an end to the difficulty which has been caused by the allied cable companies in Australia and remove all friction which has arisen between the partners in the Pacific cable; that it would lower charges to a minimum on over-sea messages passing between New Zealand, Australia, India; South Africa, the West Indies, Newfoundland, Canada, and the Mother Country, that it would provide a double means of communication at low uniform rates between the Mother Country, or any one British State and all self-governing British States; that it would constitute the most effective means by which the several governmental units of the Empire may hold communion with each other whenever they desire, and that while it would be of the highest importance to the commercial and social interests of the British people around the world, it would, by the subtle force of electricity, at once promote the consolidation of the Empire and prove an indispensable factor in Imperial unity.

**Swansea Telephones.**—On Thursday last week the new exchange building in connection with the Corporation Telephones Department was formally opened by the Mayor. Mr. H. G. Solomon (chairman of the committee) said the amount expended was £12,036. The scheme provided for 750 lines and spare accommodation for another 750. All the main routes within the borough were laid underground, and exchanges had been opened at Morriston and Mumbles. The precaution would be taken to lay additional lines at the same time as the proposed electric traction mains. The number of subscribers actually connected, added to the orders in hand, amounted to 624, and when they remembered that the National Telephone Co. only had 650 at the time the Corporation first entered into the matter, they would not be surprised when he informed them that they expected to be able to demand inter-communication by law in a month's time, when they would have reached half the number of the National Telephone Co.'s subscribers. In compliance with a general desire, inter-communication would be applied for, but he (Mr. Solomon) said he held his own opinion as to the value of such inter-communication to a corporation. To the company it meant salvation, but there were many reasons why the Corporation should not give inter-communication to the company. The Corporation service was £3 a year cheaper, and was far more efficient. The National Co. had just issued their new rates for Swansea as the result of the competition, but the lowest they could give an exclusive line for was £8 a year. That was owing to the fact that they had certain obligations to other corporations if they reduced in Swansea.

### Telegraphic Interruptions and Repairs:—

| Cables. | Interrupted. | Repaired. |
|---|---|---|
| Dominica-Martinique .. .. .. .. .. | May 5, 1903 .. .. | |
| St. Lucia-Martinique .. .. .. .. .. | May 7, 1903 .. .. | |
| Guadeloupe-Martinique .. .. .. .. .. | May 5, 1903 .. .. | |
| Anjer-Kalianda .. .. .. .. .. .. | Aug. 2, 1903 .. .. | |
| Cayenne-Pinheiro .. .. .. .. .. | Aug. 18, 1903 .. .. | |
| St. Lucia-St. Vincent .. .. .. .. .. | Sept. 19, 1903 .. .. | |
| Reissa-Issa (Yemen)-Camaran .. .. .. | Oct. 22, 1903 .. .. | |
| Paramaribo-Cayenne .. .. .. .. .. | Feb. 26, 1903 .. .. | |
| New York-Hayti .. .. .. .. .. | April 18, 1903 .. .. | |
| Trinidad-Demerara No. 2 .. .. .. .. | Oct. 22, 1903 .. .. | |
| Trinidad-Demerara No. 1 .. .. .. .. | Aug. 27, 1901 .. .. | |
| Tourane-Amoy .. .. .. .. .. .. | Nov. 10, 1903 .. .. | |

**The Telegraph Wire Export Trade.**—Another quiet month has to be recorded in the export trade of this country in telegraph wire and apparatus connected therewith, the shipments last month only attaining a value of £47,065, as compared with £431,682 in the corresponding month of last year, and £112,687 in October, 1901. The quietness which has ruled in this branch during the current year is well indicated by the returns for the figures for the 10 months ending with October last, which show that the exports have only amounted to a value of £1,619,628, as contrasted with £2,658,414 in the corresponding 10 months of 1902, a decline of over a million sterling.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Blackpool.**—November 14th. One 450-KW. traction set (vertical triple-expansion engine and multipolar generator). See "Official Notices" October 23rd.

**Brighton.**—December 7th. Six water-tube boilers, piping, tanks, and sundry other steam plant, for the Southwick power station. See "Official Notices" November 6th.

**Ceylon.**—December 1st. The Ceylon Government is inviting proposals from those willing to enter into a contract for the supply of electrical energy to the various offices, buildings, and premises of the Government. See this column for November 6th.

**Dorchester.**—November 26th. The Council is open to negotiate with companies willing to take over its electric lighting order. See "Official Notices" to-day.

**Dublin.**—November 14th. Arc lamp carbons. See "Official Notices" November 6th.

**Dublin.**—November 30th. Stores for the Dublin United Tramways Co. See "Official Notices" to-day.

**Germany.**—Tenders are at present being invited for the establishment of a central electric lighting station in the little town of Wallerfangen (Treves).

**Great Western Railway.**—December 7th. Water-tube boilers, engines, three-phase generators and auxiliary plant, for the Park Royal power station. See "Official Notices" November 6th.

**Harrogate.**—November 16th. High tension mains. See "Official Notices" October 30th.

**Hornsey.**—November 30th. Meters, indicators and fuse-boxes. See "Official Notices" November 6th.

**Italy.**—Tenders are being invited until the 30th inst. by the municipal authorities of Canosa di Puglia (Bari), for the concession of the public and private electric lighting of the town during a period of 50 years.

**Johannesburg.**—November 16th. Gas producer plant; gas engines and dynamos. Alternative:—Water-tube boilers, steam engines or turbines, electric generators, and other plant. For the municipal tramways and electrical supply scheme. See "Official Notices" August 28th.

**Kilmarnock.**—November 18th. Lancashire boilers; engines and dynamos; crane; battery; and switchboard for electricity scheme. See "Official Notices" October 9th.

**Kirkcaldy.**—November 23rd. One 400-KW. steam engine and dynamo for lighting and traction. See "Official Notices" November 6th.

**Leeds.**—November 13th. Forty-five tons of piping and valves for the electricity works. See "Official Notices" October 23rd.

**L.C.C.**—December 8th. Electric wiring of five sub-stations and three tramway car-sheds. See "Official Notices" to-day.

**L.C.C.**—December 8th. Four 3,000-KW. three-phase generators, with exciters, for the Greenwich tramway power station. See "Official Notices" to-day.

**Maesteg.**—The Council invites proposals from those willing to take over electric lighting powers for the district. See "Official Notices" November 6th.

**Middlesbrough.**—November 28th. One 600-KW. steam turbine dynamo; Lancashire boilers, condensing, and other plant. See "Official Notices" to-day.

**Newport.**—November 23rd. Three 50-B.H.P. motors with switchgear for the Electricity Committee. See "Official Notices" to-day.

**Plymouth.**—November 14th. The Corporation is inviting tenders for an electric lighting installation for the Borough Asylum, Blackadon. Specifications, &c., from Mr. E. G. Okell, borough electrical engineer.

**Preston.**—December 12th. Traction switchboard and accessories. See "Official Notices" to-day.

**Radcliffe.**—November 14th. Lighting and traction switchboards and accessories; rail bonds for the U.D.C. See "Official Notices" October 23rd.

**Swindon.**—November 16th. Steel poles, overhead equipment for tramways, arc lamps, &c., for the Corporation. See "Official Notices" November 6th.

**Swindon.**—November 23rd. Traction switchboard and feeder cables. See "Official Notices" November 6th.

**Sydney (N.S.W.).**—December 30th. Telegraph, telephone, and electric light material for the Deputy Postmaster-General of Sydney. See this column for November 6th.

**Wednesbury.**—November 20th. Electric wiring of public buildings. See "Official Notices" October 23rd.

**Whitehaven.**—November 18th. Electric wiring, &c., for the new infirmary. See "Official Notices" November 6th.

### CLOSED.

**Aberdeen.**—On 2nd inst. the Works Committee accepted the tender of Messrs. Pratt & Keith, Aberdeen, for the electric lighting of Oldmill Poorhouse, at £2,001. There were five tenders in all.

**Bootle.**—Messrs. D. Firth & Son, of Dukinfield, have secured the contract for an electrical installation at the Central Fire Station, including street fire alarms, telephones and incandescent electric lighting.

**Foyers.**—The British Aluminium Co. has placed an order with Messrs. Dick, Kerr & Co., Ltd., for two 520-KW. D.C. generators. The machines are for the Aluminium Co.'s works at Foyers, N.B., and are to be driven by turbines.

**Bromley (Kent).**—The U.D.C. has accepted the tender of the Horsfall Destructor Co. for the supply of a three-cell destructor plant, at £4,890.

**Hong Kong.**—Messrs. Johnson & Phillips have secured the contract for a 250-KW. steam alternator for the Hong Kong Electric Light Station.

**Preston.**—The Tramways Committee of the T.C. on November 5th accepted the tender of Messrs. Dick, Kerr & Co. for the permanent way and overhead equipment of the tramways, at £80,492.

**St. Helens.**—The Corporation has placed an order with Messrs. Dick, Kerr & Co., Ltd., for a 400-KW. D.C. generator.

**Westminster.**—The City Council has received the following tenders for installing electric light in Marshall Street public laundry:—

| | |
|---|---|
| A. H. Wood (recommended) .. .. .. .. | £228 |
| Laing, Wharton & Co. .. .. .. .. .. | 237 |
| J. Bolding & Sons, Ltd. .. .. .. .. .. | 256 |
| Slatter & Co. .. .. .. .. .. .. | 273 |

## FORTHCOMING EVENTS.

Friday, November 13th.—Electro-Harmonic Society Concert. King's Hall, Holborn Restaurant. Ladies' night. Mr. R. K. Gray will preside. The programme will include selections by an orchestra.

At 8 p.m. Physical Society. South Kensington. "Means for Electrifying the Atmosphere on a Large Scale," and "An Arrangement for Driving Mercury Pumps," by Sir Oliver Lodge.

At 7.30 p.m. North-East Coast Institution of Engineers and Shipbuilders. Meeting at Newcastle-on-Tyne. Presidential address and paper on "Technical Education in Germany," by Mr. Max Wurl.

Saturday, November 14th.—West Hartlepool Scientific Society. Mr. W. C. Borrowman on "The Absurdities of the present System of Measures."

At 7.30 p.m. Glasgow Technical College Scientific Society. Paper by Mr. A. Govan on "Motor-Cars."

Monday, November 16th.—Institute of Marine Engineers. Paper on "Fuel Testing."

Tuesday, November 17th.—Institution of Electrical Engineers (Manchester). Opening meeting. "Demonstration of the Properties of Radium," by Dr. Schuster.

Wednesday, November 18th.—At 8 p.m. Society of Arts. Opening meeting. Address by Sir Wm. Abney.

At 7.30 p.m. Institution of Electrical Engineers. Students' meeting.

Liverpool Engineering Society. Paper by Mr. J. B. C. Kershaw on "Fuel Economy from the Chemical Point of View."

Thursday, November 19th.—Institution of Electrical Engineers (Leeds). Paper by Mr. S. D. Schofield on "Destructor and Electricity Stations in Small Towns."

Friday, November 20th.—At 8 p.m. Junior Institution of Engineers. Paper on "Fires on Shipboard; their Chief Causes, and the Method for Prevention and Extinction," by Mr. G. Canning.

Saturday, November 21st.—At 2.30 p.m. Junior Institution of Engineers. Visit to Orchard Dock, Blackwall, to witness a demonstration of fire extinguishing, &c.

## NOTES.

**Electric Light Companies and Street Obstructions.**—The *Times* reports that, at the rooms of the Board of Trade on Tuesday, the Westminster City Council further advanced their petition to the Board for certain restrictions to be placed upon the electric lighting companies in their jurisdiction as to the times when they should have access to street boxes. Mr. Bonar Law, M.P. (Parliamentary secretary to the Board of Trade), presided, and was accompanied by the Hon. T. H. W. Pelham and Mr. A. P. Trotter (electric adviser). The companies concerned and represented were:—St. James's and Pall Mall Electric Light Co., London Electric Supply Corporation, Kensington and Knightsbridge Electric Lighting Co, Westminster Electric Supply Corporation, Charing Cross and Strand Electricity Supply Corporation, Metropolitan Electric Supply Co., and the Chelsea Electric Lighting Co. The Westminster City Council, having experienced inconvenience from the frequent opening of boxes, have prescribed that there shall be access to the boxes in certain streets only from midnight to 9 a.m., and in certain other streets from 8 p.m. to 10 a.m. The companies object to the proposed restriction.

The town clerk put the case for the City Council.

Prof. Kennedy, of the Westminster Electric Supply Corporation, presented the case for the companies. He contended that they ought to have daylight so far as possible, and alluded to the dangers if artificial light were used.

Mr. Bonar Law said that the Act of Parliament clearly made it part of the duty of the Board to sanction reasonable restrictions, and therefore they had no choice. But they had to consider what was a reasonable restriction, and in considering that, they had not only to consider the travelling public, but the consumers. He would suggest that the companies should meet and consider what they would be willing to agree to, and then that they should have a conference with the authorities of the Westminster City Council. If an agreement was arrived at, at least for the time, it might be used as an experiment. He agreed with Prof. Kennedy that it would be perfectly unreasonable that the hours should not be such as to make the bulk of the work to be done in daylight. There was inconvenience in any case, and it was only reasonable that the companies and their customers should share it. However, if they found it impossible to come to terms, then it would be for the Board to consider whether the rules laid down by the Council were or were not reasonable, and to pass or refuse to pass them.

The parties accepted the suggestion of Mr. Bonar Law that they should confer.

**London County Council.**—At the meeting on Tuesday the Council resolved to sanction the borrowing by the Islington Borough Council of £3,753 for the purchase of electricity meters.

The Highways Committee recommended the Council to hold a special meeting to consider whether notice should be given of intention to purchase the lines of the South London Tramways Co. between Vauxhall and Norwood. It was proposed to ask the local authorities concerned to contribute one-third of the net cost of the widenings of streets considered necessary, and to consent to the adoption of the overhead trolley system for the whole or a part of the tramways, which have a total length of 5¾ miles. It was decided to approve the introduction of the conduit system for the new tramway to be constructed along St. John Street, St. John Street Road and Rosebery Avenue.

The Council will next week be asked to sanction an expenditure of £90,000 for the purchase of rails and accessories for the reconstruction of the first 22½ miles of the northern tramways leased to the North Metropolitan Tramways Co., and £13,850 for the construction of a new termini at Tooting.

**Electrical Progress in the Nineteenth Century.**—Prof. Andrew Gray delivered the first of a special centenary series of lectures in connection with the Royal Philosophical Society of Glasgow on 4th inst. His subject was the "Electrical Progress in the Nineteenth Century."

**Electro-Harmonic Society.**—To-night is a "Ladies' Night" at the Electro-Harmonic. Mr. R. K. Gray, president of the Institution of Electrical Engineers, will be in the chair, and an excellent programme of vocal and instrumental music has been arranged, including selections by an orchestra, a pianoforte solo by Mr. A. E. Izard, and a violin solo by Mr. T. E. Gatehouse. The vocalists will be Miss Gertrude Maxted, Miss Lilian Gardner, and Mr. Harry Dearth. Humorous duets will be rendered by Messrs. C. Corner and F. Henry, and humorous sketches by Mr. B. Gammon. The concert takes place at the King's Hall, Holborn Restaurant, and a large muster is expected.

**The I.E.E. Dinner of the Glasgow Section.**—The annual dinner of the Glasgow section of the Institution of Electrical Engineers took place on Wednesday, the 4th inst., in the Grand Hotel, the president of the section, Mr. William A. Chamen, occupied the chair. The company included the Lord Provost, Sir John Ure Primrose, Bart., Mr. Robert Kaye Gray, president of the Institution, and Mr. W. G. McMillan, secretary, and Mr. E. G. Tidd, hon. local secretary. The Lord Provost, in responding to the toast of the "Corporation of Glasgow," said they lived in an electric age. The electric cars had made a wonderful transformation of Glasgow life. Their rapid transit along the streets was a sort of material embodiment of the onward march of the day. They owed that condition of things to the electrical engineer. But his Lordship looked to far greater development in the conditions of the city from electrical science. There was, for example, the smoke problem that times their city was rendered gloomy and oppressive owing to the smoke nuisance, but that evil, he thought, was on the verge of solution. Indeed, he said confidently the smoke problem ought not to exist; science had demonstrated that it could be settled. The Corporation had taken an onward step in one department of it—the domestic pollution of the atmosphere. They had reduced the rate for heating purposes to the power rate. But more might be done. He had been told that in the blast furnaces which fringed the city were hundreds of thousands of horse-power going to waste in the air that could supply electrical energy for heating purposes.

In replying to the toast of the "Institution of Electrical Engineers," Mr. Robert Kaye Gray testified to the favour with which the parent Institution viewed the development of the local sections. He claimed for the profession of electrical engineers that it was as well equipped as any other profession in Great Britain. Other divisions of engineering had to contend against certain disadvantages. It was difficult for those older bodies to free themselves from past practice. Glasgow was, he said, the cradle of electrical industry. In this connection he referred to the work of Lord Kelvin.

Mr. W. G. McMillan proposed the "Glasgow Local Section." In doing so he said he put the local sections in the relation of colonies to the parent Institution, adding that the latter was anxious to do its duty to keep the colonies together and to assist them in every way. Thus electrical engineers would be banded together in all countries and the interests of the profession advanced. The Glasgow Local Section he ranked as one of the strongest in the country; nor was that surprising when they remembered the distinguished men who had been connected with it. Among these he mentioned Lord Kelvin, who was the first president of the section, and he paid also a warm tribute to Mr. Chamen, the present occupant of the chair. The work of the section was economically and excellently done, and that it was so was due in large measure to the services rendered by Mr. Tidd, hon. secretary.

In reply, Mr. Chamen pointed out that the work of the sections differed in some respects from that of the parent Institution. There were in the sections a large number of members of a less highly technical kind, and it became the duty, therefore, of the local sections to encourage the reading of papers of a less technical character than those printed in the *Proceedings of the Institution*. But if the local sections did no more than keep the members together and provide them with pleasant evenings, where, over a smoke and a cup of coffee, they could discuss matters of professional interest, they would accomplish a great deal in the way of keeping the outlying branches of the great Institution together and encourage young men to join the sections.

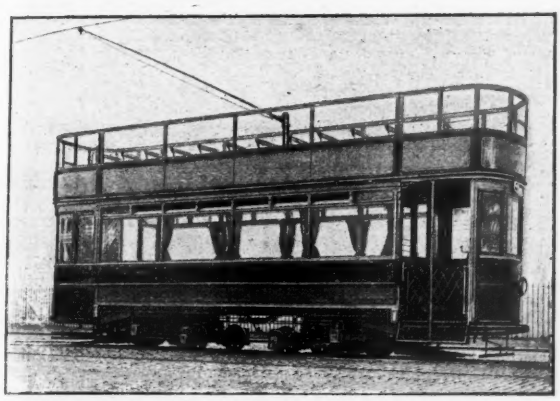
**The Association of Engineers-in-Charge.**—The programme of proceedings for 1903-4 session has been sent to us by the hon. sec., Mr. A. Davey. It is an exceedingly useful society, and we should say bids fair to become increasingly popular among the large class of practical men who rightly come under the title of "engineers-in-charge." There is some substantial fare arranged for, including a paper by Mr. W. H. Booth on "Liquid Fuel"; one by Mr. C. Wilson on "From Cotton-Wool to Candle-Power, the Evolution of an Electric Lamp"; one on "Pumps," by Mr. P. R. Bjorling; one on "Gas Engines," by Mr. Horace Allen; one on "High Speed Engines," by Mr. W. Crawford; and finally a paper on "Cast-Iron Tanks," by Mr. W. J. Jones. But it is not to be all work and no play, nor is it to be limited to engineers-in-charge, for representatives of the sex which takes charge of the engineers are to have a very large share in the play of the session. On October 31st, for instance, the commencement of work was signalised by a "concert and dance"; on January 16th there is to be further edition of "Dance"; February 27th has its "concert and dance"; on March 19th comes something more serious in the form of an annual dinner, and the last day of April has been set apart for a Bohemian Concert. By following the papers and discussions the members should become more efficient as engineers, and discreet enjoyment of the lighter indulgencies may make them whistle with a merry heart when in the engine room.

**Electrical Gold Dredging.**—In the *Engineering and Mining Journal* for October 3rd, there is an abstract of a paper read before the American Institute of Electrical Engineers by Mr. R. L. Montague, who describes the methods that have been adopted for the dredging of gold in various places, and gives the result of his experience gained for this class of work. There is probably not much demand for dredging of this nature in this country, but the figure for power required may be of interest as a comparison with dredging of other kinds. With the type of dredger in which the excavation is done by an endless chain of buckets, it is possible to handle 0·85 cb. yards of gravel (? per minute) per horse-power delivered on board. The load on the motors is an extremely variable one, and the special windings of motors and types of resistances are described in the paper. For the operation of a dredger with buckets of 5 cb. ft. capacity, open connected chain, capable of excavating to a depth of 35 ft., with a 12 in. centrifugal pump for elevating purposes, 135 KW. should be available at the bus-bars on board the dredger for 24 hours a day if the plant is of the direct current type, or 170 KVA. at 80 per cent. power factor where induction motors are used.

**Cape Town Exhibition.**—We are informed that the directors of the International Exhibition now being organised are open to receive offers for lighting the grounds, &c., and communications respecting the matter should be addressed to the managers, at Palmerston House, Old Board Street, E.C. The Belgian Government will take part officially in the exhibition, and will devote £40,000 to the purpose.

**Wind Protection for Electric Cars.**—The question of protecting passengers riding on the top decks of electric cars is receiving a great deal of attention at the present moment, and our readers will be interested in any attempt to deal with the problem. During the year we have seen various covers adopted, first by one authority and then by another, but all with doubtful permanent success; however the designs vary, they all practically reproduce the conditions obtained on the old steam cars, which were very objectionable aesthetically, hygienically, and from the point of view of comfort. To avoid the heavy lumbering covered top and yet afford all necessary protection is the object of the wind-shield arrangement designed by Mr. Henry Mozley, general manager of the Burnley Corporation tramways.

The car illustrated has been built by Messrs. G. F. Milnes & Co., Hadley, and is one of four now running at Burnley. Before the cars were built an "old" type of car was fitted with sail cloth and run for some weeks, and the protection was so good that it was resolved to have four of a consignment of 14 fitted with the wind shield to see how the idea worked out in practice. The result has



Car Provided with Wind Shield. (Reg. Design, 406,454.)

been so satisfactory that the remaining cars are to be fitted, and judging from the favour shown by users, hand rail and grilles will soon be a thing of the past in Burnley.

A fault very common in the design of cars is the low hand rail, but recently the Board of Trade have shown a disposition to have them raised, and probably it will soon be found general to have the "fence" 4 ft. 6 in. high, as is the case here.

The wind shield itself is constructed of wood and glass in lieu of the usual iron rail and grille, and its height is just sufficient when a passenger is seated to "bring" him below the top rail. The framing is made of well-seasoned straight-grained ash well framed together, secured to deck by brackets of angle steel and by steel angles inserted between the vertical uprights, and at a convenient height diagonal stays are riveted, the other ends being secured to the roof of the car. The screen is glazed with ¼ in. polished plate glass, fixed with rubber strip, and the lower part panelled in sheet-steel brought right down to deck, having scalloped openings at intervals on each side to allow drainage. The frame is protected on the top side by ½ in. × ⅜ in. convex iron, and the glass windows may be protected inside by suitable railing, but so far this has not been found necessary.

The end framing is arranged to receive the destination indicator, and the painting harmonises with the rest of the car. An additional advantage of the wind shield over iron rails and grilles is obtained by reason of the security from shocks due to live hand railing.

**The Elland Combined Electricity Works and Destructor.**—Owing to the large accumulation of solid matter extracted from the sewage and the dry ashes and other refuse which, tipped into the Ainleys were rapidly becoming a public nuisance, the local authorities decided to put up a refuse destructor. Having decided upon this, the problem was what to do with the steam which might be generated from the furnaces, and after some consideration it was decided to erect an electricity works in conjunction with the destructor.

The works have recently been opened, the total installation costing about £17,000. The destructor consists of two cells, capable of destroying one ton of refuse per hour. It is of the Meldrum regenerative type with two grates prepared for either top or front feed. It was the original intention to feed the destructor from the top, but as the work progressed, the Council saw the good work that was being done by the front-feed type all over the country, that they decided, for the present, to forego the heavy expense of inclined roadways, &c, and to feed the cells from the front by hand.

A Lancashire boiler, working at 200 lbs. pressure receives the heat from the furnaces after passing through the usual flues and combustion chamber. A Babcock boiler has also been fitted with Meldrum furnaces for burning coke, breeze and other cheap fuel, and has a capacity of 1½ tons per hour. The electrical equipment consists of two sets, each of a capacity of 140 kw., and there is also a storage battery, having a capacity of 700 ampere-hours. The works start with a fairly good load, and it is anticipated that they will be on a profit-making basis in the second year.

**Henley's New Premises.**—We noted in a recent issue that Messrs. W. T. Henley's Telegraph Works Co., Ltd., had removed their warehouse and offices from the neighbourhood of Cannon Street, where they had been for so many years, to much larger premises at Blomfield Street, London Wall. The new warehouses and offices have an historical interest, in that they have been for about 70 years the centre of the operations of the London Missionary Society, and the scene of many of its thrilling experiences which were associated with the work of Dr. Livingstone, Dr. Robert Moffatt, and others. It is interesting to note that Sir Henry Stanley, the man who found Livingstone in the heart of Africa, is a director of the great electrical company which now occupies the old premises from which Livingstone had his send-off.

**Institution of Electrical Engineers (Birmingham).**—The opening meeting of the session, which was to have been held on 18th inst., has been postponed.

**Scientific Societies: Arrangements for the 1903-4 Session.**—The scientific and engineering societies in all parts of the country are now settling down in earnest to the work of the winter session, and there is so much of electrical interest in the programmes issued, that we have thought it worth printing a note of some of the more important papers and events arranged for:—

*Institution of Electrical Engineers (Manchester).*

December 15th.—A. C. Eborall, "Polyphase Electric Traction."
January 19th.—A. S. Giles, "Coal Consumption in Central Stations."
February 2nd.—W. Chilton, "Steam Turbines."
February 16th.—J. M. McElroy, "Manchester Tramways Equipment: Line and Rolling-Stock."
February 26th.—Annual Dinner.
March 1st.—H. L. Kirker, "The Mersey Railway Multiple Control System."
March 24th.—Joint meeting with the Liverpool Engineering Society. J. L. Hunt, "Notes on the Design of Electrical Machinery."
March 29th.—T. W. Sheffield, "Safety Devices for Electric Traction."

*Institution of Electrical Engineers (Leeds).*

November 19th.—S. D. Schofield, "Combined Electricity and Destructor Stations."
December 17th.—E. H. Crapper, "Methods of Charging for Electrical Energy."
January 21st.—H. Bohle, "Alternators in Parallel."
February 18th.—W. Emmott, "Some Experiments with Large Gas Engines."
March 10th.—H. A. Wraith, "Description of an Electrical Equipment of an Engine Works."
April —.—A. L. C. Fell, "Oil Extraction from Exhaust Steam in Boiler Feed Water."

*Society of Arts.*

December 2nd.—Sir Chas. M. Kennedy, "Fiscal Reform."
December 16th.—Sir Wm. H. Preece, "Science and Industry."
Dates not fixed.—E. O. Sachs, "Lessons to be Learnt from the Fire Brigade Appliances at the late International Fire Exhibition."
Prof. C. V. Boys, "Thermit."
T. C. Clarkson, "Steam Motors."
March 7th, 14th, 21st.—Cantor Lectures.—Bertram Blount "Recent Advances in Electro-Chemistry."

*Junior Institution of Engineers.*

November 20th.—G. Canning—"Fires on Shipboard; their Chief Causes and Methods for Prevention and Extinction."
January 22nd.—J. F. Moulton, K.C., Presidential Address.
February 5th.—H. Williams, "Producer Gas-Power for Factories, Cold Stores and Freezing Works."
February 13th.—Annual dinner.
March 4th.—G. C. Allingham, "Some Practical Notes on Electric Storage Batteries."
May 12th.—Conversazione.
April 8th.—K. Gray, "The Heating and Ventilation of Factories."

*Glasgow Technical College Scientific Society.*

November 14th.—A. Govan, "Motor-Cars."
November 28th.—J. H. Pocock, "Some Remarks on the Willans-Engine."
December 5th.—W. H. Booth, "Superheat."
December 12th.—A. A. Wynne, "Steam Turbine Machinery."
January 9th.—A. G. Strathern, "The Manufacture of Weldless Chains."
February 6th.—Annual Dinner.
February 20th.—A. MacLean, "Modern Conceptions of Matter."
March 5th.—M. Pickstone, "British Competition and Manufacture."
March 19th.—A. J. Lawson, "The Diesel Engine for Marine Purposes."

*West Hartlepool Scientific Society.*

November 14th.—W. C. Borrowman, "The Absurdities of the Present System of Measures."
December 12th.—W. Kennedy, "Mr. D. B. Morrison's Scheme for the Advancement of Apprentices."
January 9th.—J. W. Patterson, "Boiler Feed Water."
February 13th.—I. V. Robinson, "Balancing of Marine Engines."
March 12th.—"Three-Wire System."

*Liverpool Engineering Society.*

November 18th.—J. B. C. Kershaw, "Fuel Economy from the Chemical Point of View."
December 2nd.—E. J. Hidden, "Recent Telephone Developments in Liverpool."
December 16th.—H. W. Wilson, "Polyphase Working."
January 13th.—W. Norris, "Motor Vehicles."
January 20th.—H. S. Meyer, "Voltage Regulation in Alternating Current Plants."
January 27th.—E. W. Marchant, "Induction Motors."
February 10th.—E. K. Scott, "Electric Transmission from Water Powers."
February 24th.—G. Balfour, "Conduit and Surface Contact Tramway Systems."
March 10th.—J. R. Smith, "Steam Boiler Failures."
March 24th.—J. L. Hunt, "Notes on Design of Electrical Machinery."

*Society of Engineers.*

November 30th.—A. Gay, "Mechanical Stokers."

**Lectures.**—Prof. C. A. Carus-Wilson, M.A., M.I.E.E., was to commence a special course of lectures to the senior students of the Electrical Standardising, Testing and Training Institution upon "Direct Current Motor Construction" yesterday.

**Personal.**—The completion of the cable laying for the electric lighting and tramways at Glossop by Callender's Cable and Construction Co. has been marked by the presentation of a framed photograph of the employés to Mr. H. W. Pierce, a gold mounted umbrella to Mrs. Pierce, and a silver mounted pipe to Mr. H. G. Purkiss.

Mr. R. E. Fisher, night manager of the Chelmsford Arc Works, of Messrs. Crompton & Co., who is leaving for Aston, Birmingham, has been presented by the staff and employés with an 18-carat gold keyless watch.

It is announced that Mr. R. E. Shawcross, A.M.I.C.E., has been appointed Demonstrator in Electrical Engineering at King's College.

On Wednesday, the 4th inst., Mr. W. Booker was presented at the Electricity Works, Plumstead, with a handsome set of books from his late colleagues. He left these works, where he held the appointment of correspondence clerk, to take up a similar appointment in the electricity works of the borough of Hampstead.

**Appointments Vacant.**—A borough electrical engineer and manager is required for Poplar (£400); a tramways manager is required for Gloucester at £300 (rising to £450); assistant in the electrical engineering department at the Central Technical College, Exhibition Road (£150); temporary electrical draughtsman for the Metropolitan Asylums Board; mains superintendent for Bexhill; shift engineer for Bexley (£75).

**Obituary.**—Engineers all the world over will hear with deep regret of the death of Prof. R. H. Thurston, the well-known American expert on steam engine matters. From the American exchanges just to hand we gather that on October 25th he had just returned from a brisk walk, and was awaiting the arrival of some guests who were to dine with him, when he suddenly fell into a stupor. All the efforts of his wife and friends to rouse him were useless, and death occurred before medical assistance was at hand. The late professor was 64 years of age, and had since 1885 been director of the Sibley College of Cornell University, Ithaca, New York. Previous to that, from 1871 to 1885, he was Professor of Engineering at the Stevens Institute of Technology. His work connected with steam engineering has been of very great value, and his contributions to the literature of the steam engine and the steam turbine—in the future supremacy of which he was a firm believer—are esteemed by English engineers as much as by American.

## THE CENTRAL STATION ENGINEER.

Mr. Lironi, engineer at the Portsmouth tramway power station, has had his salary raised from £200 to £250 by the Corporation Tramways Committee.

Aston U.D.C., on November 5th, appointed Mr. Thos. J. Ballard, as resident electrical engineer, at a salary of £400 a year.

The staff of the Lowestoft electric and tramway departments, on November 5th, presented marble timepieces to Mr. G. A. Bruce, resident electrical engineer and general manager of the tramways, and Mr. G. W. Steward, superintendent engineer, on their marriages.

Mr. T. B. Naylor, assistant electrical engineer to the Dudley Corporation, has been appointed successor to the late Mr. Marsh, who recently met his death under such distressing circumstances.

The East Ham U.D.C. has appointed Mr. Thomas Aitken (late P. & O.) to the post of mechanical engineer at the electricity works (at £180), and has increased the salary of Mr. W. R. Elliott, station superintendent, from £160 to £180.

On the 10th inst., at the office of the Electric Light & Power Co., Wellingborough, Mr. J. B. Clarke, the managing engineer, was presented with a marble clock and illuminated address from the staff and friends on the occasion of his departure to take up a similar position at Stourbridge. Mr. A. C. Evans, in making the presentation, spoke of the goodwill existing between Mr. Clarke and the staff, and on their behalf wished him all success and prosperity.

## ELECTRICITY SUPPLY ACCOUNTS.

### Oldham Municipal Electricity Department.

The last returns of the Oldham electrical department show a considerable advance on those of the previous year. The traction supply, although it has not yet realised the original expectations of its promoters, has, at any rate, eclipsed the private lighting supply; the maximum lighting load was 768 kw., and traction load 975 kw.

The revenue is nearly double that of the previous year, and with improved works costs, a gross profit of £12,612 has been earned, compared with £5,876 in 1902.

Strangely enough, motive power supply in the district is practically undeveloped, although the matter is under consideration by the Corporation, and should, in the ordinary course of events, yield a profitable business.

The scale of charges was as follows:—For private lighting, for successive thousands of units per quarter, from 4d. to 2d. per unit; above 5,000, 1½d. per unit, or on the maximum demand system, 4d. per unit for the first two hours and 1½d. after. Public street lighting, 2½d., and traction, 1½d. per unit. Mr. S. Wilmot Newington is the borough electrical engineer.

General Statement.

| For year ending March 25th— | 1903. | 1902. |
|---|---|---|
| Total capital expended ... ... ... | £216,882 | £108,309 |
| Number of units sold ... ... ... | 2,869,312 | 1,042,055 |
| Equivalent No. of 8-c.p. lamps ... ... | 54,154 | 45,389 |
| Number of public arc lamps ... ... | 20 | 25 |
| Maximum load in kw. ... ... ... | 1,743 kw. | 990 kw. |
| Revenue account— | | |
| Gross revenue ... ... ... ... | £26,279 | £13,509 |
| „ expenditure ... ... ... | £13,667 | £7,633 |
| „ profit ... ... ... ... | £12,612 | £5,876 |
| Average price obtained per unit— | | |
| Private lighting... ... ... ... | 3·43d. | 3·46d. |
| Public lighting ... ... ... ... | 2·50d. | 2·50d. |
| Traction ... ... ... ... | 1·69d. | 2·00d. |

Revenue Account.

| | 1903. Gross. | Per unit. |
|---|---|---|
| Sale of energy ... ... ... ... ... | £25,764 | 2·16d. |
| Meter rents, &c. ... ... ... ... ... | 407 | ·03d. |
| Miscellaneous ... ... ... ... ... | 108 | ·01d. |
| Gross revenue ... ... | £26,279 | 2·20d. |

Costs of Production.

| | Gross. | Per unit. |
|---|---|---|
| Coal ... ... ... ... ... ... ... | £5,975 | ·50d. |
| Oil, waste, water and engine room stores ... | 551 | ·04d. |
| Salaries and wages incurred in generation and distribution ... ... ... ... ... | 2,248 | ·19d. |
| Repairs and maintenance of machinery, buildings and plant ... ... ... ... ... | 2,655 | ·22d. |
| Works and distribution costs ... ... | £11,429 | ·95d. |
| Rents, rates and taxes ... ... ... ... | 1,216 | ·12d. |
| Management expenses, salaries of engineer and clerical staff ... ... ... ... ... | 427 | ·03d. |
| General establishment charges, including stationery, printing, law, insurance, bad debts, &c. ... ... ... ... ... ... | 595 | ·05d. |
| Total works costs ... ... | £13,667 | 1·15d. |

Profit Statement.

| | |
|---|---|
| To interest on loans, &c. ... ... ... ... | £4,953 |
| To sinking fund ... ... ... ... ... | 2,988 |
| To surplus on year's working carried forward ... | 4,671 |
| Gross profit ... ... ... ... | £12,612 |

The gross profit on the year's working amounted to £12,612, and after meeting financial charges a surplus of £4,671 remained, which, with the balance from the last account and bank interest amounting to £1,490, makes a total balance in hand of £6,161.

The department also possesses a reserve fund amounting to £4,969.

### Nelson Municipal Electric Supply.

This year's returns of the Nelson electricity department include a traction supply for the first time, and as a result the output is more than treble that of the previous year. The Corporation supply in bulk to the Brierfield U.D.C., and also to the tramways from Nelson to Brierfield, and the Barrowfield and Nelson Light Railway.

As a result of the improved conditions of supply works cost per unit have decreased from 2·53d. to 1·54d., and despite the greater output, total only £2,055, as compared with £1,015 last year; the gross profit has correspondingly increased to £2,327, as compared with £879 in the previous year. Mr. W. Alan Fraser is the borough electrical engineer.

General Statement.

| For year ending March 31st— | 1903. | 1902. |
|---|---|---|
| Total capital expended ... ... ... | £59,753 | £42,919 |
| Number of units sold— | | |
| Private lighting, &c. ... ... ... | 137,670 | 93,708 |
| Motive power ... ... ... ... | 6,371 | 2,500 |
| Traction ... ... ... ... ... | 176,422 | — |
| Total number of units sold ... | 320,463 | 96,208 |
| Equivalent No. of 8-c.p. lamps connected | 15,500 | 12,500 |
| h.p. of motors connected ... ... ... | 80 | 13½ |
| Maximum load in kw. ... ... ... | 360 | 146 |
| Revenue account— | | |
| Gross revenue ... ... ... ... | £4,382 | £1,694 |
| „ expenditure ... ... ... | £2,055 | £1,015 |
| „ profit ... ... ... ... | £2,327 | £879 |

**Revenue Account.**

| | 1903. Gross. | Per unit. |
|---|---|---|
| By sale of energy ... ... ... ... ... | £3,590 | 2·70d. |
| Meter and motor rents ... ... ... ... | 95 | ·07d. |
| Wages, materials, superintendence, &c. ... | 697 | ·52d. |
| Gross revenue ... ... ... | £4,382 | 3·29d. |

**Cost of Production.**

| | Gross. | Per unit. |
|---|---|---|
| Coal, &c. ... ... ... ... ... ... | £602 | ·45d. |
| Oil, waste, water and engine room stores ... | 156 | ·12d. |
| Wages incurred in generation and distribution | 145 | ·11d. |
| Repairs and maintenance of buildings, machinery, and plant... ... ... ... ... ... | 473 | ·35d. |
| Works and distribution costs ... ... | £1,376 | 1·03d. |
| Rent, rates and taxes ... ... ... ... | 148 | ·11d. |
| Management expenses, salaries of engineer and clerical staff ... ... ... ... ... | 337 | ·25d. |
| General establishment charges, insurance, law, printing and stationery... ... ... ... | 194 | ·15d. |
| Total works costs ... | £2,055 | 1·54d. |

Despite the great improvement in gross profit, the department, after meeting the increased financial charges (*i.e.*, £2,843 as compared with £864 last year), made a net loss of £516. This, however, is the first deficit since 1893, the opening year, and in the interval the department has contributed its net profits, amounting to £1,273, to the general district rate.

**Profit Statement.**

| | |
|---|---|
| Interest on loans ... ... ... ... | £1,481 |
| Sinking fund ... ... ... ... ... | 1,362 |
| Deficit on year's working ... ... ... | — 516 |
| Gross profit ... ... ... ... | £2,327 |

# CITY NOTES.

## Edison & Swan United Electric Light Co.

Mr. Henry Wolfenden presided at the annual meeting held at Winchester House last Friday. In moving the adoption of the report, he said that last Christmas Mr. Ellice Clark was compelled under medical advice to retire from the chair of the company, but he retained his seat on the board. Mr. Wolfenden, himself, was then elected to the chair. They had not been able to hold the meeting earlier; every effort had been made to do so, but the great detail involved would preclude having the meeting earlier than October, and they would endeavour to keep to that date in future. The accounts were presented in a different form from those of previous years; the detailed profit and loss account had been omitted, only the balance to net revenue being stated. That change was foreshadowed in the chairman's speech last year, as the expediency of giving the figures of an industrial undertaking was somewhat doubtful. The balance of profit or loss carried to net revenue was the figure which was of most interest to shareholders, and he hoped that they would agree that the alteration was the right thing in the interests of the company. The year's sales showed a decrease, but that deficiency was more than recouped by economies in costs of production and other expenses. Since June 30th the sales showed improvement as compared with the corresponding period of 1902. The net result of the year had been that they carried to the credit of net revenue account £30,834, as against £26,312, an increase of £4,522. That balance had been arrived at after pricing the stocks upon prudent and conservative lines; any articles which, owing to market fluctuations or lessened cost of production, or from other reasons might be considered as being lower in value, had been written down accordingly. The directors believed that no further reductions in the pricing of the stocks would be necessary unless some unforeseen circumstances arose such as the falling value of raw materials, or decreased cost of manufacture and so on, which they did not anticipate. Debenture interest was £18,760. Depreciation at the rate of 1 per cent. had been allowed on the freehold and leasehold property, at 6 per cent. for plant, and a sum had been set apart as a reserve on account of bad and doubtful debts (as stated in the report). The chairman said that his experience of manufacturing works had been that liberal appropriation for depreciation had always made for the solidity of a business, and in the long run would not be regretted. They had also applied £6,174 in reduction of value of stocks after pricing them as previously named. Some portion of that amount represented the ordinary depreciation which necessarily was always going on to a greater or less extent consequent upon change of fashion, alteration of design, &c., in some of the goods in which the company dealt. In regard to the stores at Ponder's End, parts of machines, &c., in store upon which work had been commenced or ordered prior to the present board taking office, these were taken into stock in 1902 at the prices of partially-finished work, as the intention then was to utilise them to completion, but afterwards it was deemed best not to do so, hence they had now been taken at scrap value, and the special charge on that account should not recur. Sundry creditors and credit balances figured £19,942 smaller than last year; on the other side of the account they had owing to them an amount which was lower than last year by £12,642. What they might call the cash position was that they owed £26,103 and had £65,000 in hand or realisable to deal with. After giving a few facts relating to the Altrincham electric supply undertaking, the chairman said that the stocks and plant together represented £245,516—a reduction of £5,162 as compared with last year. Objection was made that the stocks were disproportionately large, as compared to the turn-over. The matter was having their closest attention, but the stock included not only finished goods for sale, but all stores in progress both for lamps and engineering at factories. The cost of establishing the business was brought forward at the same figure as before. Shareholders had expressed a desire to see that figure written down. To deal with that and other balances might involve writing down the capital, but as they did not propose paying any dividend, they did not propose to do that at the present moment. Competition was very keen, but they were in a stronger position than had been the case previously. They were making steady progress, and that progress continued up to that day. They were getting stronger daily, and they looked to the future with confidence.

Mr. Ellice Clark seconded the report.

In replying to some critical and other observations made by shareholders, the Chairman said that one speaker had asked whether they were prepared to consider the policy of closing branches. It was not a question of one or two; they must deal with the thing broadly, or not at all. It involved other considerations, and they had given the matter close and careful attention, and they were not at the moment prepared to close the branches unless shareholders insisted upon it, as it would not be for the company's interests. In regard to lamp manufacture, he was perfectly satisfied that the company could produce lamps in competition with anyone in the world; he would not have said that two years ago. Mr. Lea Smith had asked were the stocks down to bedrock. He would not say that they had nothing obsolete; the prices were all down to bedrock absolutely. The company's position was better because of the decrease of general working expenses, and the increase in revenue. As to writing down the capital, that was a matter which they would act upon if the shareholders gave the mandate. They should not act upon it prematurely; they would know more shortly. The stocks—that was finished goods and work in progress—stood at £175,000, and the plant at £97,340. The main items of the stocks had been gone over by the board, but every screw and nail had not been valued by them. The three directors drew £3,000 between them as their fees.

## St. Helens and District Tramsways Co.

Mr. J. B. Atherton presided at the fourth annual general meeting held at Liverpool. When moving the adoption of the report, he stated that the total receipts for the past year amounted to £36,925 as compared with £30,771 in the previous year. In the year before last the net profit was given as £1,650, which was about £1,100 short of paying the capital redemption policy premiums, amounting to £2,720 per annum. In the past year the net balance was £2,784, which was a little over the amount paid in redemption policy premiums, or something like £1,200 better than in the previous year. The result would no doubt have been much better but for the continuous bad weather. They had also had an accident, which cost the company £500. Up to the present time the company had paid £15,000 towards the capital redemption policy, and in this way the capital of the shareholders was being safeguarded in the best possible manner.

The report and balance-sheet were adopted.

Mr. J. B. Atherton, the retiring director, was re-elected, and the auditors, Messrs. Chalmers, Wade & Co., were re-appointed.

## Prospectuses.

*The Sunderland District Electric Tramways, Ltd.*, has been before the investing public this week with an issue of 750 first debentures of £100 each at 5 per cent., 100,000 £1 6 per cent. cumulative preference shares, and 100,000 £1 ordinary shares. The company has powers to lay 19¼ route miles of 4 ft. 8½ in. electric tramway in the large and populous colliery district in the neighbourhood of Sunderland. The engineers to the company are:—Messrs. D. Balfour and Son, of Newcastle; Messrs. Handcock & Dykes; and Messrs. Harper Bros. & Co. The list was to close yesterday. The construction of part of the lines is now in progress. The equipment is being undertaken by the Electric Conversion Syndicate for £227,500, who received tenders from Messrs. Krauss & Son, and other contractors, for the permanent way, power station building, equipment of line, and 30 double-deck cars for the sum of £202,500. The Conversion Syndicate are the vendors together with the Ito Syndicate, and the United Kingdom Tramway, Light Railway and Electrical Syndicate. The vendors take £36,500 in cash for the prov. order and for the works already carried out.

Messrs. Glyn, Mills, Currie & Co., on behalf of the *Metropolitan District Railway Co.*, invite subscriptions until to-morrow (Saturday) for £500,000 4 per cent. perpetual debenture stock. The work

of converting the railway from steam to electricity is steadily progressing, and the engineers anticipate that the whole system will be equipped and ready for working by the end of next year. It is intended to provide eventually on the main line a service of 40 trains per hour, as against 18 trains now running, and on each of the five suburban western branch railways a 10 minutes' service. During the year ended June 30th last the passengers numbered 43,203,584. When the system is electrically equipped and in full working order, the company expects to carry at least 100,000,000 passengers per annum. It is intended to apply part of the net proceeds of this issue for the general purposes of the company, and the balance will, from time to time, be paid over to the Underground Electric Railways Co. of London, Ltd., for the work of electrification.

## Eastern Extension, Australasia and China Telegraph Co., Ltd.

THE report for the half-year ended June 30th states that the gross receipts amounted to £265,099 against £283,856 for the corresponding half-year of 1902. The working expenses, including £29,613 for maintenance of cables, absorb £138,516 against £121,237 for the corresponding period of 1902, leaving a balance of £126,582. From this is deducted £5,955 for income-tax, and £11,771 for interest on debenture stock, &c., leaving £108,856 as the net profit for the half-year. After adding £37,180 brought forward, there is an available balance of £146,036. Two quarterly interim dividends of 1½ per cent. each, amounting to £75,000, have been paid for the half-year, leaving a balance of £71,036 to be carried forward. The agreement concluded with the Australian Federal Government, for extending to Melbourne and Brisbane the privilege enjoyed by the company in other State capitals of Australia of dealing direct with the telegraphing public, has been formally approved by the Federal House of Representatives, but the Senate has deferred coming to a definite decision upon it pending the result of a conference to be held between the interested Governments to consider what effect the agreement may have upon the British Pacific cable, and other questions. Meanwhile the tentative arrangement come to with the Federal Government by which the company is allowed to work a special wire between Adelaide and Melbourne and to deal direct with the public in the latter city remains undisturbed.

## West India and Panama Telegraph Co.

THE directors' report for the half-year ended June 30th, 1903, to be submitted to the meeting on November 18th, reads:—

The directors submit the accounts for the six months ended June 30th, 1903. The amount to credit of revenue is £34,903 10s. 11d., against £28,970 17s. 9d. for the corresponding half-year of 1902. The expenses have been £23,051 14s. 2d. against £22,399 15s. 4d., leaving a balance of £11,851 16s. 9d., to which is added £2,127 14s. 4d. interest on investments, and £1,914 2s. brought from last account making a total of £15,893 13s. 1d., with which it is proposed to deal as follows:—

| | | |
|---|---|---|
| Payment of 8s. per share on account of arrears of dividend to June 30th, 1903, on the first preference shares .. .. .. .. .. .. .. | £13,825 | 4 0 |
| Balance to current half-year's account .. .. .. | 3,068 | 9 1 |
| | £15,893 | 13 1 |

This will leave the following dividends in arrear:—

| | | |
|---|---|---|
| On the first preference shares .. .. .. .. | £3,456 | 6 0 |
| On the second preference shares .. .. .. | 8,404 | 4 0 |
| | £11,860 | 10 0 |

Owing to the greater quantity of cable used, the expenses of repairing cables during the half-year amounted to £9,751 10s. 1d., being £802 7s. 8d. more than those for the corresponding period. The company's new cable steamer, the *Henry Holmes*, arrived in the West Indies in June to relieve the *Nercington*, which was thereupon brought back to England and her charter terminated. The West India colonies are hopeful that the International Convention for the abolition of foreign sugar bounties, which came into force last September, will be beneficial to them when it has had time to come fully into operation.

**Stock Exchange Notices.**—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to:—Dick, Kerr & Co., Ltd.—61,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 61,000, and £300,000 4½ per cent. debenture stock And to allow the following securities to be quoted in the Official List:—Bath Electric Tramways, Ltd.—59,394 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 59,394, and 75,606 preferred ordinary shares of £1 each, fully paid, Nos. 75,001 to 150,606. The Committee (1) appointed special settling days as under:—Wednesday, November 11th.—Charing Cross and Strand Electricity Supply Corporation, Ltd.—40,000 "City Undertaking" 4½ per cent. cumulative preference shares (1903) of £5 each, fully paid, Nos. 40,001 to 80,000; London United Tramways (1901), Ltd.—Further issue of £206,000 4 per cent. first mortgage debenture stock; and ordered same to be quoted in the Official List.

## STOCKS AND SHARES.

Wednesday Evening.

UNTIL the Bank of England advances its discount rate to 5 per cent., there are sure to be regular apprehensions of tighter money as each Thursday comes round, and, perhaps, the best thing that can happen is for the Bank Rate to rise, thereby putting an end to the uncertainty. Business is hardly likely to be more restrained than it remains at present, and investment markets have practically abandoned hopes of better trade for the next few weeks. As things are, the New Year is the star upon which the Stock Exchange fixes its anticipatory gaze in regard to a general revival of public interest in the markets.

Fortunately for itself, the Telegraph market has a feature of exceptional strength in the Anglo-American Telegraph Co.'s trio. The Ordinary stock is up 3 points, the Preferred 2, and the Deferred 1, this latter, of course, being much the heaviest advance, having regard to the proportion of prices. The rise is due to an idea that the dividend on the Deferred—the "A"—stock may reach as much as 5s., as against one shilling paid last February. Besides this, it is pointed out that the company's reserve fund has nearly reached the million pounds at which the market understands it will be allowed to rest, profits thereafter being diverted to the Deferred stock, instead of going to swell the reserve, as at present. There is, of course, nothing new in this, nor has the company's business recently attained to such a volume as to make so sudden a rise in prices thereby justified. But the market happened to be short of stock when a few buyers came along, and it required little demand to advance the quotations materially. As though in defence of the jump, the dealers draw attention to the fact that Anglo "A" pays a dividend and yet stands much lower than such things as Chatham Ordinary, Little Trunks or Erie Common shares, none of which are likely to receive a distribution for years to come.

Direct United States Cable shares have not sympathised with the rise in Anglo descriptions, but Submarine Cables Trust certificates have recovered the point they lost last week, while Globe Telegraph Ordinary and Preference are both a ¼ easier. West India and Panama First Preference are 5s. better upon the dividend of 8s. per per share on account of arrears.

Of the Eastern group, "China" shares fell 10s. upon the issue of a report showing a decrease in takings and an advance in expenditure. That this would be the case was pretty well known in advance, but such pre-knowledge failed to save the price from falling, although the Debenture stock has gained a point. Eastern Telegraph Ordinary is down the same amount, sympathetically with the weakness in "China" shares, but here, again, the Debenture stock has improved.

National Telephone Preferred at 101 is better, and Orientals ⅛ easier.

The Sunderland District Electric Tramways, Ltd., appeals for £200,000 in equal amounts of Ordinary and Preference shares, and £75,000 in 5 per cent. debentures, but no market has been made in any of the issues up to the present. It may be pointed out that the Electric Conversion Syndicate is to receive £12,500, payable as to £8,000 in cash, and £4,500 in cash or fully-paid shares, for guaranteeing a minimum share subscription of 150,000 shares, which is equal to about 8½ per cent. Even if part of this commission should be paid in shares, the rate looks substantial enough in all conscience.

In the Home Railway market, Waterloo and City stock has fallen 2 per cent. upon a sharp relapse in London and South-Western issues due to an offer of both Ordinary and prior-charge securities at unpopular prices. Central London Ordinary is 2 down upon a slight pressure to sell. But the principal interest in this market revolves round Metropolitan Consolidated, which, in a market otherwise weak, has been steadily bought upon the capital traffics, and the approach of electrification. The price has risen 2 to 84 since we last wrote, but the improvement has extended no helping hand to Districts, which are lower at 31. New District 4 per cent. Debenture stock is offered to the public at par, and there is no premium on it in the market.

Amongst the Electricity Supply shares, Metropolitans at 17½ have receded the fraction, the increase in the Progressive party in the Marylebone Borough Council being regarded with suspicion. London Electric Preference are down ¼, and two or three of the Debentures have come on offer, with the consequence of point losses here and there.

Traction shares remain quietly firm, without much variation. Metropolitan Electric Trams are weak, and have been done at at 3s. 9d., while New General Traction Ordinary have dropped to the rubbish quotation of 0—½, the Preference being dull at 2. Potteries Ordinary were bought on Tuesday at 9¼, and the Preference are about the same price. Cape Electrics have fallen still further to 2 middle, on the report to which we drew attention last week. Calcutta shares are 6⅞, and at 4½ Anglo-Argentines keep steady. British Columbia Electric Railway Deferred is a point easier at 84½, and British Electric Tractions are unaltered on the week. Castner-Kellners have relapsed to 15s., the interim dividend on the Ordinary shares having been passed.

# SHARE LIST OF ELECTRICAL COMPANIES.

## TELEGRAPH AND TELEPHONE COMPANIES.

| Present Issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1900. | 1901. | 1902. | Closing Quotations Nov. 4th. | Closing Quotations Nov. 11th. | Business done week ended Nov. 11th, 1903. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| 67,100 | African Direct Telegraph, 4 % Debs. | 100 | .. | .. | .. | 99 —103 | 99 —103 | 99 | .. |
| 25,000 | Amazon Telegraph Co.'s shares, Nos. 1 to 25,000 | 10 | .. | .. | .. | 2½ — 3½ | 2½ — 3½ | .. | .. |
| 119,700† | Do. do. 5 % Debs., Nos. 1 to 1,250 Red. | 100 | .. | .. | .. | 70 — 80 | 70 — 80 | .. | .. |
| 788,840 | Anglo-American Telegraph | Stock | 3½% | 6½s. | 6d/6 | 46 — 49 | 49 — 52 | 42½ | .. |
| 3,105,580 | Do. do. do. 6 % Pref. | Stock | 6 % | 6 % | 6 % | 91 — 93 | 93 — 95 | 94½ | 92½ |
| 3,105,580 | Do. do. do. Deferred | Stock | 5s. % | 2s. | 1/- | 7½ - 7¾ | 8½ — 1⅛ | 8¾ | 7½ |
| 44,000 | Chili Telephone, Nos. 1 to 44,000 | 5 | 5 % | 5 % | 6 % | 4½ — 5½ | 4½ — 5½ | .. | .. |
| 13,333,30 $ | Commercial Cable | $100 | 8 % | 8 % | 8 % | 145 —155 | 145 —155 | .. | .. |
| 1,841,209 | Do. do. Sterling 500 year 4 % Deb. Stock Red. | Stock | .. | .. | .. | 90 — 93 | 90 — 93 | 92½ | 90½ |
| 16,000 | Cuba Telegraph | 10 | 4½% | 4 % | 6½% | 7 — 8 | 7 — 8 | 7 | .. |
| 6,000 | Do. 10 % Pref. | 10 | .. | .. | .. | 16 — 17 xd | 16 — 17 | .. | .. |
| 12,931 | Direct Spanish Telegraph | 5 | 4 % | 4 % | 4 % | 2½ — 3½ | 2½ — 3½ | .. | .. |
| 6,000 | Do. do. 10 % Cum. Pref. | 5 | .. | .. | .. | 7 — 8 | 7 — 8 | .. | .. |
| 90,000 | Do. do. 4½ % Debs. | 50 | .. | .. | .. | 98 —102 % | 96 —100 | .. | .. |
| 60,710† | Direct United States Cable | 20 | 3¼% | 3¼% | 3¼% | 10⅜ — 10⅝ | 10¼ — 10⅜ | 10⅜ | .. |
| 87,800 | Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red. | 100 | .. | .. | .. | 99 —102 | 99 —102 | .. | .. |
| 4,000,000 | Eastern Telegraph, Ord. Stock | Stock | 7 % | 7 % | 7 % | 123 —128 | 122 —127 | 125 | 122½ |
| 1,955,565 | Do. 8½ % Pref. Stock | 100 | .. | .. | .. | 88 — 89 | 86 — 89 | 87½ | 86 |
| 1,584,645 | Do. 4 % Mort. Deb. Stock Red. | Stock | .. | .. | .. | 104 —107 xd | 105 —108 | 106½ | 105 |
| 800,000 | Eastern Extension, Australasia, and China Telegraph | 10 | 7 % | 7 % | 7 % | 11½ — 12 | 11½ — 12 | 11¾ | 11 7/16 |
| 320,000† | Do. 4 % Deb. Stock | Stock | .. | .. | .. | 104 —107 | 105 —108 | 106 | .. |
| 800,000 | Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909 | 100 | .. | .. | .. | 99 —102 | 99 —102 | .. | .. |
| 200,000† | Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000 | 25 | .. | .. | .. | 98 —101% xd | 98 —101 % | .. | .. |
| 180,227 | Globe Telegraph and Trust | 10 | 5½% | 5½% | .. | 8¾ — 9½ xd | 8½ — 9 | 8 1/16 | .. |
| 180,042 | Do. do. 6 % Pref. | 10 | .. | .. | .. | 12¾ — 13⅛ xd | 12¼ — 13 | 12 13/16 | 12½ |
| 150,000 | Great Northern Telegraph, of Copenhagen | 10 | 15 % | 15 % | 12½% | 22½ — 23½ | 22½ — 23½ | .. | .. |
| 62,500‡ | Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red. | 100 | .. | .. | .. | 99 —102 | 99 —102 | .. | .. |
| 17,000 | Indo-European Telegraph | 25 | 10 % | 10 % | 10% | 36 — 39 xd | 36 — 39 | 38⅜ | 37½ |
| 100,000† | London Platino-Brazilian Telegraph, 6 % Debs. | 100 | .. | .. | .. | 98 —102 | 98 —102 | .. | .. |
| 1,983,333 | National Telephone, Pref. Stock | 100 | 5 % | 5 % | 6 % | 99 —101 | 100 —102 | 101⅜ | 99 |
| 1,966,667 | Do. do. Def. Stock | 100 | .. | .. | 4½% | 74 — 76 | 74 — 76 | 75½ | 74 |
| 15,000 | Do. do. 6 % Cum. 1st Pref. | 10 | 6 % | 6 % | 6 % | 13 — 14 | 13 — 14 | .. | .. |
| 15,000 | Do. do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | 6 % | 13 — 14 | 13 — 14 | .. | .. |
| 2,250,000 | Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000 | 5 | 5 % | 5 % | 5 % | 5 — 5½ | 5 — 5½ | 5⅛ | .. |
| 600,000† | Do. do. 3½ % Deb. Stock Red. | Stock | 3½% | 3½% | 3½% | 93 — 95 | 93 — 95 | 94½ | 93½ |
| 600,000 | Do. do. 4 % Deb. Stock Red. | 100 | 4 % | 4 % | 4 % | 102 —104 | 102 —104 | 102⅝ | 102⅜ |
| 179,313 | Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid | 1 | 6 % | 6 % | 6 % | ⅞ — 1 xd | 15/16 — 1 | .. | .. |
| 50,000 | Do. do. do. 6 % Cum. Pref. | 1 | .. | .. | .. | 1 — 1⅛ | .. | .. | .. |
| 100,000† | Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 | 100 | .. | .. | .. | 97 —100 | 97 —100 | .. | .. |
| 11,889 | Reuter's | 8 | 5 % | 5 % | .. | 6¾ — 7½ | 6¾ — 7½ | .. | .. |
| 3,808 | Submarine Cables Trust | Cert. | .. | .. | .. | 115 —120 | 116 —121 | .. | .. |
| 68,000 | United River Plate Telephone | 5 | 7 % | 7 % | 7 % | 5¾ — 6 | 5¾ — 6 | 5⅞ | .. |
| 40,000 | Do. do. 5 % Cum. Pref., Nos. 1 to 40,000 | 5 | .. | .. | .. | 4¾ — 5½ | 4¾ — 5½ | 5 1/16 | .. |
| 179,947† | Do. do. 5 % Debs. | Stock | .. | .. | .. | 104 —107 | 104 —107 | .. | .. |
| 15,600 | West African Telegraph, Shares | 10 | .. | .. | 2 % | 5 — 6 | 5 — 6 | .. | .. |
| 150,000† | West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel. | 100 | .. | .. | .. | 95 — 98 | 95 — 98 | 97 | .. |
| 207,930 | Western Telegraph, Ltd., Nos. 1 to 207,930 | 10 | 7 % | 7 % | 7 % | 12 — 12½ | 12 — 12½ | 12⅜ | 12 1/16 |
| 75,000† | Do. do. 5 % Debs. 2nd series, 1906 | 100 | .. | .. | .. | 100 —103 | 100 —103 | .. | .. |
| 400,000 | Do. do. 4 % Deb. Stock Red. | 100 | .. | .. | .. | 98 —101 | 98 —101 | .. | .. |
| 88,321 | West India and Panama Telegraph | 10 | 1½% | .. | .. | ⅜ — ½ | ⅜ — ½ | 7/16 | .. |
| 84,563 | Do. do. do. 6 % Cum. 1st Pref. | 10 | .. | .. | .. | 6 — 6¼ | 6¼ — 6⅜ | 6 1/16 | 6⅜ |
| 4,669 | Do. do. do. 6 % Cum. 2nd Pref. | 10 | .. | .. | .. | 3¾ — 4½ | 3¾ — 4½ | .. | .. |
| 80,000† | Do. do. do. 5 % Debs., Nos. 1 to 1,800 | 100 | .. | .. | .. | 101 —104 | 101 —104 | .. | .. |

## ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 20,000 | British Aluminium 7 % Cum. Pref. | 10 | .. | .. | .. | 4½ — 5½ | 4½ — 5½ | .. | .. |
| 800,000 | Do. do. 5 % 1st Mort. Deb. Stock Red. | Stock | .. | .. | .. | 85 — 89 | 85 — 89 | .. | .. |
| 100,000 | British Electric Traction | 10 | 9 % | 9 % | 8 % | 11½ — 12 | 11¾ — 12 | 11⅞ | 11 3/16 |
| 100,000 | Do. do. 6 % Cum. Pref. | 10 | .. | .. | .. | 11 — 11½ | 11 — 11½ | 11⅜ | 11⅛ |
| 600,000† | Do. do. 5 % Perpetual Debenture Stock | Stock | .. | .. | .. | 120 —123 | 120 —123 | 122½ | 121½ |
| 100,000 | British Insulated and Helsby Cables | 5 | 15 % | 10 % | 10 % | 6¼ — 6⅜ | 6¼ — 6⅜ | 6⅜ | .. |
| 100,000 | Do. do. 6 % Cum. Pref. | 5 | .. | .. | .. | 5¼ — 5⅜ | 5¼ — 5⅜ | .. | .. |
| 50,000 | Do. do. 4½ % 1st Mort. Deb. Red. | 100 | .. | .. | .. | 102 —105 | 102 —105 | .. | .. |
| 50,000 | ¶Browett, Lindley & Co., Ord. | £1 | 8 % | Nil | .. | 3/16 — ¼ | 3/16 — ¼ | .. | .. |
| 50,000 | Do. do. 6 % Cum. Pref. | £1 | 6 % | 6 % | .. | 14/6 to 15/6 | 14/6 to 15/6 | .. | .. |
| 105,731 | Brush Electrical Engineering, Ord., 1 to 105,731 | 2 | 5 % | Nil | Nil | ⅜ — 1½ | ⅜ — 1½ | .. | .. |
| 150,000 | Do. do. Non-cum. 6 % Pref. | 2 | 6 % | 3 % | 6 % | 1½ — 1¾ | 1½ — 1¾ | .. | .. |
| 125,000 | Do. do. 4½ % Perp. Deb. Stock | Stock | .. | .. | .. | 97 —100 | 97 —100 | .. | .. |
| 125,000 | Do. do. 4½ % Perp. 2nd Deb. Stock | Stock | .. | .. | .. | 85 — 90 | 85 — 90 | .. | .. |
| 85,000 | Callender's Cable Construction shares | 5 | 15 % | 20 % | 15 % | 11 — 12 xd | 11½ — 12¾ | 11⅛ | .. |
| 40,000 | Do. do. do. 5 % Cum. Pref. | 5 | .. | .. | .. | 5½ — 5⅞ | 5⅝ — 5⅞ | 5⅝ | 5½ |
| 90,000† | Do. do. do. 4½ % 1st Mort. Deb. Stock Red. | Stock | .. | .. | .. | 106 —110 | 106 —110 | 1·9 | .. |
| 1,860,014 | Central London Railway, Ord. Stock | Stock | .. | 4 % | 4 % | 95 — 98 | 93 — 96 | 95½ | 9½ |
| 494,093 | Do. do. 4 % Pref. Stock | Stock | .. | 4 % | 4 % | 99 —102 | 99 —102 | 100½ | 99½ |
| 494,998 | Do. do. Def. do. | Stock | .. | 4 % | 4 % | 99 —102 | 99 —102 | .. | .. |
| 1,330,000 | City and South London Railway | Stock | 1½% | 2 % | 3½% | 51 — 53 | 51 — 53 | 52 | 50½ |
| 85,000 | Crompton & Co., Nos. 1 to 85,000 | 8 | 8 % | 7½ % | 5 % | 1¾ - 2¼ | 1¾ - 2¼ | .. | .. |
| 100,000 | Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red. | .. | .. | .. | .. | 100 —104 | 100 —104 | .. | .. |
| 99,261 | Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261 | 5 | 2½% | Nil | .. | 0 — ¼ | 0 — ¼ | .. | .. |
| 17,139 | Do. do. "A" shares, 01—017,139 | | 2½% | Nil | .. | 1½ — 2¼ | 1 — 2 | .. | .. |
| 344,023† | Do. do. 4 % Deb. Stock Red. | 100 | .. | .. | .. | 72 — 77 | 72 — 77 | 74 | 73½ |
| 100,000† | Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd. | 100 | .. | .. | .. | 76 — 81 | 76 — 81 | .. | .. |
| 112,100 | Electric Construction, 1 to 112,100 | 2 | 6 % | 6 % | 6 % | 1½ — 1⅝ | 1½ — 1⅝ | .. | .. |
| 81,390 | Do. do. 7 % Cum. Pref., 1 to 81,390 | 2 | .. | .. | .. | 2¼ — 3 | 2½ — 3 | .. | .. |
| 82,500† | Do. do. 4 % Perp. 1st Mort. Deb. Stock | Stock | .. | .. | .. | 97 —100 | 97 —100 | .. | .. |
| 25,000 | General Electric Co. (1900), 5 % Cum. Pref. | 10 | 5 % | 5 % | 5 % | 9¾ — 10½ | 9¾ — 10½ | .. | .. |
| 200,000 | Do. do. 4 % Mort. Deb. | Stock | .. | .. | .. | 96 — 99 | 96 — 99 | .. | .. |
| 35,000 | Henley's (W. T.) Telegraph Works, Ord. | 5 | 20 % | 20 % | 20 % | 14 — 15 | 14 — 15 | .. | .. |
| 35,000 | Do. do. 4½ % Pref. | 5 | 4½% | .. | .. | 5 — 5½ | 5 — 5½ | 5 | .. |
| 46,050 | Do. do. 4½ Mort. Deb. Stock | Stock | .. | .. | .. | 108 —112 | 108 —112 | .. | .. |
| 50,000 | India-Rubber, Gutta-Percha & Telegraph Works | 10 | 10 % | 10 % | 10 % | 18½ — 19½ | 18½ — 19½ | 18 1/16 | 18½ |
| 800,000† | Do. do. do. 4 % 1st Mort. Deb. | 100 | .. | .. | .. | 100 —103 | 100 —103 | 100 | .. |
| 87,500 | Liverpool Overhead Railway, Ord. | 10 | 3½% | 1½% | 1½% | 4⅝ — 4⅞ | 4¼ — 4½ | .. | .. |
| 10,000 | Do. do. Pref. £10 paid | 10 | .. | .. | .. | 10¼ — 10⅝ | 10¼ — 10⅝ | .. | .. |
| 87,350 | Telegraph Construction and Maintenance | 12 | 17½% | 20 % | 20 % | 34 — 37 | 34 — 37 | 35⅜ | 34½ |
| 150,000 | Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909 | 100 | .. | .. | .. | 100 —103 | 101 —104 | .. | .. |
| 540,000 | Waterloo & City Railway, Ord. Stock | 100 | 3 % | 3 % | 3⅜% | 93— 96 | 91 — 94 | 93 | 92 |

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd. 1903).

## SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

| Present issue. | NAME. | Stock or Share. | Dividends for the last three years. 1900. | 1901. | 1902. | Closing Quotations Nov. 4th. | Closing Quotations Nov. 11th. | Business done week ended Nov. 11th, 1903. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| 100,000 | Blackheath and Greenwich Dist. Electric Light, Ord... .. .. | ‡ | .. | .. | .. | ⅝— ⅞ | ⅝— ⅞ | .. | .. |
| 100,000 | Do. 4½% 1st Deb. Stock, Prov. Certs. | 1 | .. | .. | .. | .. | .. | .. | .. |
| 20,000 | Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 .. | 100 | .. | .. | .. | 116 —119 | 116 —119 | .. | .. |
| 20,000 | Do. do. 7 % Cum. Pref. .. | 5 | 6 % | 8 % | 8 % | 10½— 10⅝ | 10½— 10⅝ | .. | .. |
| 50,000 | Charing Cross and Strand Electricity Supply .. .. .. | 5 | .. | .. | .. | 10 — 10½ | 10 — 10½ | 10⅛ | 10 |
| 70,000 | Do. do. 4½% Cum. Pref. .. | 5 | 9 % | 10 % | 10 % | 9 — 9⅛ | 9 — 9⅛ | 9⅛ | .. |
| 40,000 | Do. do. "City Undertaking" 4½% Cum. Pref. .. | 5 | .. | .. | .. | 5⅛— 5⅜ | 5⅛— 5⅜ | .. | .. |
| 250,000 | Do. do. 4 % Deb. Stock Red. .. .. .. .. | 100 | .. | .. | .. | 4¼— 5 | 4¼— 5 | .. | .. |
| 44,486 | *Chelsea Electricity Supply, Ord. .. .. .. .. .. .. | 5 | 5⅛% | 4 % | 4⅛% | 104 —106 | 104 —106 | 104⅜ | 104½ |
| 150,000£ | Do. do. % Deb. Stock Red. .. .. .. .. | Stock | .. | .. | .. | 5⅛— 6 | 5⅛— 6 | 5⅜ | .. |
| 70,595 | City of London Electric Lighting, Ord. 40,001—110,595 .. | 10 | 0 % | 5 % | 5 % | 108 —111 | 108 —111 | .. | .. |
| 40,000 | Do. 6 % Cum. Pref., 1 to 40,000 .. .. .. .. .. | 10 | 6 % | .. | .. | 9⅜— 10⅛ | 9⅜ — 10⅛ | 10⅛ | 10 |
| 400,000£ | Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid .. .. | .. | .. | .. | .. | 13 — 14 | 13 — 14 | 13⅜ | 13½ |
| 800,000 | Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid .. .. | 100 | .. | .. | .. | 122 —127 | 122 —127 | .. | .. |
| 40,000 | County of London & Brush Prov. Electric Lighting, Ord. 1—40,000.. | 10 | 4 % | 4 % | 4 % | 102 —105 | 102 —105 | .. | .. |
| 20,000 | Do. do. do. 6 % Pref., 40,001—60,000.. | 10 | .. | .. | .. | 7⅛— 8⅛ | 7⅛— 8⅛ | 8⅛ | .. |
| 400,000£ | Do. do. 4½% Deb. Stock .. .. .. .. .. | .. | .. | .. | .. | 11⅛— 12⅜ | 11⅛— 12⅜ | 11⅜ | .. |
| 250,000 | Do. do. 4½% 2nd Deb. Stock .. .. .. .. | Stock | .. | .. | .. | 107 —110 | 107 —110 | 108 | .. |
| 50,000 | Edmundson's Electric Corporation, Ord. Shares .. .. .. | 5 | 7 % | 7 % | 7 % | 99 —102 xd | 99 —102 | .. | .. |
| 80,000 | Do. do. 6 % Cum. Pref. .. .. .. .. | .. | .. | .. | .. | 6⅜— 6⅝ | 6⅜— 6⅝ | .. | .. |
| 140,000 | Do. do. 4½% 1st Mort. Deb. Stock .. | 100 | .. | .. | .. | 6 — 6⅛xd | 6 — 6⅛ | 6⅛ | 6⅝ |
| 21,000 | Kensington and Knightsbridge Electric, Ord. .. .. .. .. | 5 | 12 % | 10 % | 10 % | 105 —108 | 104 —107 | 106¼ | .. |
| 90,000 | Do. do. do. 4 % Debenture Stock .. | Stock | .. | .. | .. | 10¼— 11¼ | 10¼— 11¼ | .. | .. |
| 110,000 | London Electric Supply Corporation, Limited, Ord. .. .. .. | 3 | .. | .. | .. | 101 —104 | 101 —104 | .. | .. |
| 49,840 | Do. do. do. 6 % Pref. .. .. .. | 5 | .. | .. | .. | 1⅜— 2⅛ | 1⅜— 2⅛ | .. | .. |
| 250,000£ | Do. do. do. 4 % 1st Mort. Deb. Stock Red | Stock | .. | .. | .. | 5 — 5⅛ | 5 — 5⅛ | .. | .. |
| 100,000 | Metropolitan Electric Supply, 1 to 100,000 .. .. .. .. .. | 10 | 6 % | 6½% | 7½% | 100 —102 | 98 —101 | .. | .. |
| 71,196 | Do. do. 4½% Cum. Pref. 1—71,106, £3 paid .. | 5 | .. | .. | .. | 17⅛— 18⅜ | 17 — 18 | 17⅞ | .. |
| 220,000£ | Do. do. 4½% 1st Mort. Deb. Stock .. .. | .. | .. | .. | .. | 4⅛— 4⅜ | 4⅛— 4⅜ | .. | .. |
| 250,000£ | Do. do. 3½% Mort. Deb. Stock Red .. .. | Stock | .. | .. | .. | 110 —114 | 110 —114 | .. | .. |
| 10,852 | Notting Hill Electric Lighting .. .. .. .. .. .. | 10 | 7 % | 6 % | 6 % | 97 —100 | 96 — 99 | 97½ | .. |
| 40,000 | St. James' and Pall Mall Electric Light, Ord. .. .. .. .. | 5 | 14½% | 14½% | 14½% | 12⅛— 13⅛ | 12⅛— 13⅛ | .. | .. |
| 20,000 | Do. do. do. 7 % Pref. 20,001 to 40,000 | 5 | .. | .. | .. | 14⅛— 15⅛ | 14⅛— 15⅛ | 14¼ | .. |
| 150,000£ | Do. do. do. 3½% Deb. Stock Red .. | 100 | .. | .. | .. | 8 — 9 | 8 — 9 | .. | .. |
| 12,000 | Smithfield Markets Electric Supply, Ord. .. .. .. .. | 5 | .. | .. | 2½% | 97 —100 | 97 —100 | .. | .. |
| 50,000 | Do. do. 4 % Deb. Stock .. .. | Stock | .. | .. | .. | 5 — 3⅛ | 3 — 3⅛ | .. | .. |
| 65,000 | South London Electricity Supply, Ord. .. .. .. .. .. | 5 | .. | .. | 12½% | 85 — 90 | — — | 85⅛ | 85⅛ |
| 80,000 | Urban Electric Supply, Ord. .. .. .. .. .. | 5 | .. | .. | .. | 3⅛— 4 | 3⅛— 4 | .. | .. |
| 80,000 | Do. do. 5 % Cum. Pref. .. .. .. .. | 5 | .. | .. | .. | 4⅛— 5⅛ | 4⅛— 5⅛ | 5 | .. |
| 110,000 | Westminster Electric Supply, Ord. .. .. .. .. .. | 5 | 10½% | 10½% | 12 % | 4⅛— 5 | 4⅛— 5 | 5 | 4⅛ |
| 98,141 | Do. do. 5 % Cum. Pref. .. .. .. .. | 5 | .. | .. | .. | 12 — 13 | 12 — 13 | 12⅛ | 12⅛ |
| | | | | | | 6 — 6⅛ | 6 — 6⅛ | 6⅛ | .. |

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

## MARKET QUOTATIONS, Wednesday, November 11th.

| | CHEMICALS, &c. | | Latest Price. | Week's Inc. or Dec. |
|---|---|---|---|---|
| *a* | Acid, Hydrochloric .. .. | per cwt. | 5/- | .. |
| *a* | ,, Nitric .. .. .. .. | per cwt. | 22/- | .. |
| *a* | ,, Oxalic .. .. .. .. | per cwt. | 32/- | .. |
| *a* | ,, Sulphuric .. .. .. | per cwt. | 5/6 | .. |
| *a* | Ammoniac, Sal .. .. .. | per cwt. | 42/- | .. |
| *a* | Ammonia, Muriate (crystal) .. | per ton | £33 10 | .. |
| *a* | ,, ,, .. .. .. | per ton | £30 | .. |
| *a* | Bleaching powder .. .. | per ton | £4 10 | .. |
| *a* | Bisulphide of Carbon .. .. | per ton | £15 | .. |
| *a* | Borax .. .. .. .. | per ton | £13 | .. |
| *a* | Benzole (90 %) .. .. .. | per gal. | 7/- | .. |
| *a* | ,, (50/90 %) .. .. .. | per gal. | 5/6 | .. |
| *a* | Copper Sulphate .. .. .. | per ton | £20 | .. |
| *a* | Lead, Nitrate .. .. .. | per ton | £24 | .. |
| *a* | ,, White Sugar .. .. .. | per ton | £31 | .. |
| *a* | ,, Peroxide .. .. .. | per ton | £27 10 | .. |
| *a* | Methylated Spirit .. .. .. | per gal. | 2/6 | .. |
| *a* | Naphtha, Solvent (90% at 160° C). | per gal. | 5/6 | .. |
| *a* | Potash, Bichromate, in casks .. | per lb. | 3d. | .. |
| *a* | ,, Caustic (75/80%).. .. | per ton | £24 | .. |
| *a* | ,, Bisulphate .. .. | per ton | £35 | .. |
| *a* | Shellac .. .. .. .. | per cwt. | 223/- | 13/- inc. |
| *a* | Sulphate of Magnesia .. .. | per ton | £4 10 | .. |
| *a* | Sulphur, Sublimed Flowers .. | per ton | £6 10 | .. |
| *a* | ,, Recovered .. .. | per ton | £5 10 | .. |
| *a* | ,, Lump .. .. .. | per ton | £5 | .. |
| *a* | Soda, Caustic (white 70 %) .. | per ton | £10 15 | .. |
| *a* | ,, Crystals .. .. .. | per ton | £3 | .. |
| *a* | ,, Bichromate, casks.. .. | per lb. | 2½d. | .. |
| | **METALS, &c.** | | | |
| *b* | Aluminium Ingots, in ton lots .. | per ton | £130 | .. |
| *b* | ,, Wire, in ton lots .. | per ton | £168 | .. |
| *b* | ,, Sheet, in ton lots .. | per ton | £166 | .. |
| *p* | Babbitt's metal ingots .. .. | per ton | £43 to £130 | .. |
| *c* | Brass (rolled metal 2" to 12") basis | per lb. | 7d. | .. |
| *c* | ,, Tube (brazed) .. .. | per lb. | 9d. | .. |
| *c* | ,, ,, (solid drawn).. .. | per lb. | 7¾d. | .. |
| *c* | ,, Wire, basis.. .. .. | per lb. | 7½d. | .. |
| *c* | Copper Tubes (brazed) .. .. | per lb. | 9¼d. | .. |
| *c* | ,, ,, (solid drawn) .. | per lb. | 9¾d. | .. |
| *g* | Copper Bars (best selected .. | per ton | £73 | .. |

| | METALS, &c. (*continued*). | | Latest Price. | Week's Inc. or Dec. |
|---|---|---|---|---|
| *g* | Copper Sheet .. .. .. | per ton | £73 | .. |
| *g* | ,, Rod .. .. .. .. | per ton | £73 | .. |
| *e* | ,, (Electrolytic) Bars .. | per ton | £67 | .. |
| *e* | ,, ,, Sheets .. | per ton | £77 | .. |
| *e* | ,, ,, Rod .. | per ton | £69 | .. |
| *e* | ,, ,, H.C. Wire | per lb. | 8¼d. | .. |
| *f* | Ebonite Rod .. .. .. | per lb. | 3/8 | .. |
| *f* | ,, Sheet .. .. .. | per lb. | 8/- | .. |
| *n* | German Silver Wire .. .. | per lb. | 1/6 | .. |
| *h* | Gutta-percha fine .. .. | per lb. | 8/- | .. |
| *h* | India-rubber, Para fine .. .. | per lb. | 3/10 to 3,11½ | dec. |
| *i* | Iron, Charcoal Sheets .. .. | per ton | £18 | .. |
| *i* | ,, Pig (Cleveland warrants) | per ton | 42/10 | 4d. dec. |
| *i* | ,, Forgings, according to size | per ton | From £11 | .. |
| *i* | ,, Scrap, heavy .. .. | per ton | 47/6 to 50/- | .. |
| *i* | ,, Wire, galvanised No. 8 .. | per ton | £9 15 | .. |
| *g* | Lead, English Ingot .. .. | per ton | £11 7 6 to £11 10 | 2/6 dec. |
| *g* | ,, ,, Sheet .. .. | per ton | £13 | .. |
| *m* | Manganin Wire No. 28 .. .. | per lb. | 8/- | .. |
| *g* | Mercury .. .. .. .. | per bot. | £8 7 6 | .. |
| *d* | Mica (in original cases) small .. | per lb. | 4d. to 1/6 | .. |
| *d* | ,, ,, ,, medium | per lb. | 2/6 to 3/9 | .. |
| *d* | ,, ,, ,, large .. | per lb. | 4/- to 7/9 | .. |
| *p* | Phosphor Bronze, plain castings | per lb. | 1/- to 1/2½ | .. |
| *p* | ,, rolled bars & rods | per lb. | 1/- to 1/3 | .. |
| *p* | ,, ,, strip & sheet | per lb. | From 1/1 | .. |
| *o* | Platinum .. .. .. .. | per oz. | £4 | .. |
| *p* | Silicium Bronze Wire .. .. | per lb. | 9d. to 11d. | .. |
| *i* | Steel, Magnet, acc'd'g to desc'p'n | per ton | £58 | .. |
| *i* | ,, ,, in bars .. .. | | £15 to £40 | .. |
| *g* | Tin, Block .. .. .. .. | per ton | £119 10 to £120 10 | 50/- dec. |
| *g* | ,, Foil .. .. .. .. | per lb. | 1/6 | .. |
| *n* | ,, Wire, Nos. 1 to 16 .. .. | per lb. | 1/7 | .. |
| *p* | White Anti-friction Metals— "White Ant" brand .. | per ton | £42 to £62 | .. |
| *j* | Yarns, 2/10s Grey Cotton, on sp'ls | per lb. | 8d. | .. |
| *j* | ,, 6 lea. Flax .. .. .. | per lb. | 5¾d. | .. |
| *j* | ,, 3 ply 10 lbs. Russian .. | per lb. | 4½d. | .. |
| *j* | ,, 10 lbs. Russian, single .. | per lb. | 4¾d. | .. |
| *j* | ,, 180 lbs. Jute rove .. | per ton | £11 | .. |
| *k* | Zinc, Sh's (Vieille Montagne bnd.) | per ton | £23 15 | .. |

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

## ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| | Locality. | Week ending | Receipts for the week. £ | £* | Total to date. £ | £* | Miles open. | * |
|---|---|---|---|---|---|---|---|---|
| | Aberdeen .. .. .. | Nov. 7 | 1,109 | +294 | 29,559 | + 4,790 | 10 | — |
| | Birmingham .. .. | ,, 7 | 5,067 | + 15 | 229,136 | + 9,119 | — | — |
| | Bournemouth .. .. | ,, 4 | 894 | — | — | — | 10½ | — |
| | Blackburn .. .. .. | — | — | — | — | — | 12½ | +1¾ |
| | Blackpool .. .. .. | ,, 5 | 838 | — 5 | 35,627 | — 210 | 8½ | — |
| | Blackpool and Fleetwood | ,, 7 | 216 | + 11 | 19,465 | — 125 | 7½ | — |
| | Blackpool and Lytham .. | Oct. 31 | 259 | +152 | 12,505 | + 6,498 | — | — |
| | Bolton .. .. .. | Nov. 8 | 1,6e7 | +113 | 59,970 | + 7,457 | 25 | — |
| | Bradford .. .. .. | — | — | — | — | — | 41 | +4 |
| | Brighton .. .. .. | ,, 8 | 866 | +118 | 44,411 | — | 6½ | — |
| | Bristol .. .. .. | ,, 6 | 4,521 | — 60 | — | — | 28 | — |
| | Burnley .. .. .. | ,, 7 | 777 | + 90 | — | — | 7½ | — |
| B.E.T. Co. | Barnsley District .. | Oct. 30 | 176 | — | 7,875 | — | 4½ | — |
| B.E.T. Co. | Devonport .. .. | ,, 30 | 456 | + 52 | 19,942 | + 987 | 5 | — |
| B.E.T. Co. | Dudley—Stourbridge.. | ,, 30 | 821 | + 71 | 36,620 | + 3,101 | 18½ | — |
| B.E.T. Co. | Gateshead .. .. | ,, 30 | 937 | +102 | 38,054 | + 5,056 | 10½ | + ¾ |
| B.E.T. Co. | Gravesend—Northfleet | ,, 30 | 235 | + 39 | 10,607 | + 1,043 | 3½ | — |
| B.E.T. Co. | Greenock—Pt. Glasgow | ,, 30 | 549 | +137 | 23,187 | + 1,980 | 7½ | — |
| B.E.T. Co. | Hartlepool .. .. | ,, 30 | 272 | + 50 | 11,877 | + 707 | 6½ | +2 |
| B.E.T. Co. | Kidderminster .. .. | ,, 30 | 108 | — 7 | 5,688 | + 175 | 4½ | — |
| B.E.T. Co. | Merthyr .. .. .. | ,, 30 | 203 | + 24 | 8,675 | — 145 | 3 | — |
| B.E.T. Co. | Middleton .. .. | ,, 30 | 269 | + 40 | 14,091 | + 1,739 | 8½ | — |
| B.E.T. Co. | Oldham—Ashton .. | ,, 29 | 549 | + 28 | 24,925 | + 1,571 | 8 | — |
| B.E.T. Co. | Peterborough .. .. | ,, 30 | 122 | — | 6,507 | — | — | — |
| B.E.T. Co. | Poole .. .. .. | ,, 30 | 258 | + 14 | 13,460 | + 1,981 | 3½ | — |
| B.E.T. Co. | Potteries .. .. | ,, 30 | 1,881 | +109 | 68,666 | + 5,666 | 28½ | — |
| B.E.T. Co. | Rotherham .. .. | ,, 30 | 46 | + 1 | 5,687 | + 1,002 | 2½ | — |
| B.E.T. Co. | Sheerness .. .. | ,, 28 | 60 | — | 2,648 | — | 2½ | — |
| B.E.T. Co. | Southport .. .. | ,, 30 | 276 | 47 | 13,928 | 9,586 | 6 | — |
| | Swansea .. .. .. | ,, 30 | 478 | + 2 | 22,728 | + 1,880 | 5½ | — |
| | Taunton .. .. .. | ,, 30 | 54 | + 1 | 2,691 | — 193 | 1½ | +1½ |
| | Tynemouth .. .. | ,, 30 | 527 | — 30 | 14,009 | + 801 | 3½ | — |
| | Weston-super-Mare.. | ,, 28 | 99 | — 7 | 5,503 | — 498 | 2½ | +2½ |
| | Wolverhampton Dist. | ,, 30 | 382 | + 61 | 17,094 | + 7,497 | 10½ | +8 |
| | Wrexham .. .. | ,, 30 | 112 | — | 4,350 | — | — | — |
| | Yorks. Woollen Dist.. | ,, 20 | 634 | — | 13,755 | — | 6 | — |
| | Cardiff .. .. .. | ,, 31 | 1,931 | +376 | 62,167 | +17,756 | 14 | — |
| | Chatham & District Co. | Nov. 5 | 545 | +159 | 24,013 | +13,172 | 8·53 | — |
| | Dover .. .. .. | ,, 7 | 177 | — 12 | 10,071 | + 68 | 3 | — |
| | Dublin .. .. .. | ,, 6 | 4,601 | + 89 | 100,151 | + 7,527 | 46½ | — |
| | East Ham .. .. .. | ,, 7 | 667 | + 209 | 22,072 | + 6,534 | 5 | + ½ |
| | Glasgow .. .. .. | ,, 7 | 13,719 | +1051 | 316,042 | +33,963 | 66 | + 6 |
| | Hull .. .. .. | ,, 7 | 1,899 | +177 | 60,112 | + 3,180 | 11½ | +1½ |
| | Ilkeston .. .. .. | ,, 4 | 188 | — | — | — | 4 | — |
| | Isle of Thanet .. .. | ,, 7 | 356 | + 4 | 31,494 | — 1,602 | 10½ | — |
| | Leeds .. .. .. | ,, 7 | 4,829 | + 13 | 180,088 | +10,710 | 41 | — |
| | Liverpool .. .. .. | Oct. 31 | 10,226 | + 895 | 444,847 | +14,527 | 108 | — |
| | Manchester .. .. | Nov. 7 | 11,174 | +5910 | 378,807 | +229,130 | 72 | — |
| | Newcastle .. .. .. | ,, 7 | 3,546 | +454 | — | — | 17 | — |
| | Portsmouth .. .. | ,, 7 | 1,531 | +249 | — | — | 14½ | — |
| | Salford .. .. .. | — | — | — | — | — | 30 | — |
| | Southampton .. .. | ,, 5 | 967 | — 2 | — | — | 9 | — |
| | Sunderland .. .. | ,, 8 | 1,033 | + 71 | 40,685 | + 2,028 | 20 | +8 |
| | Central London Railway | ,, 7 | 6,859 | —283 | 117,925 | — 6,262 | 6 | — |
| | City and S. London Ry. | ,, 8 | 2,997 | — 562 | 48,767 | — 7,662 | 5½ | — |
| | Dublin and Lucan Elwy. | ,, 8 | 105 | + 18 | 2 578 | + 155 | 6½ | — |
| | Liverpool Overhead Ry. | ,, 1 | 1,588 | + 61 | 30,853 | + 965 | — | — |

* Compared with the corresponding period of 1902.

# THE BRITISH ASSOCIATION, SOUTHPORT, 1903.

## ON THE USE OF CAPACITIES AS MULTIPLIERS IN CONNECTION WITH ELECTROSTATIC VOLTMETERS ON ALTERNATING-CURRENT CIRCUITS.

By Prof. E. W. Marchant, D.Sc., and G. W. Worrall, B.Sc., Liverpool University.

(*Abstract of paper read before Section A, September 15th*, 1903.)

The measurement of high potential differences necessitates the use of voltmeters more or less cumbrous and expensive, since in all electrostatic instruments there is a liability to sparking between the plates. High P.D.'s may, however, be measured by lower reading voltmeters in several ways. The only methods hitherto adopted have been by the use of non-inductive resistances connected in series with the voltmeter, either shunted or unshunted, and by the use of transformers. The first method becomes quite impracticable with high pressures on account of the large waste of power involved, while the latter method becomes equally cumbrous on account of the difficulties of insulation and the length of wire required in winding the apparatus. The experiments described below have been directed to the construction of a simple and easily made apparatus by which low-reading electrostatic voltmeters may be employed on circuits of much higher tension. The voltmeters used

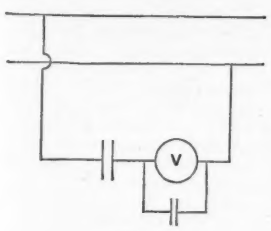



Fig. 1.

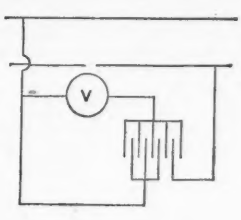



Fig. 2.

were of the Kelvin multicellular and the Ayrton and Mather electrostatic types. The method of combining the voltmeter with the capacities is to connect a capacity in series with the voltmeter across the mains and shunt another capacity across the terminals of the voltmeter, the latter capacity being large compared with the capacity of the voltmeter. Fig 1 is a diagram of the connections.

Consider two capacities connected in series across the mains.

Let $C_1$ and $C_2$ be the values of the capacities in farads;
$R_1$ and $R_2$ be their respective insulation resistances;
$V_1$ and $V_2$ be the respective P.D.'s between the terminals of the capacities;
E be the total P.D. between the mains.

If the insulation resistances of the condensers are high, then

$$\frac{V_2}{E} = \frac{C_1}{C_1 + C_2}.$$

Also, if the insulation resistances are equal, that is, if

$$\frac{R_1}{R_2} = \frac{C_2}{C_1}; \text{ then } \frac{V_2}{E} = \frac{C_1}{C_1 + C_2}.$$

This will most probably be the case if the plates of both capacities are of the same size and the sheets of dielectric of the same material, size, and thickness, the difference in the values of the capacities being produced by using different numbers of sheets, since then both leakage currents through the material and those over the surface of the dielectric will be proportional to the number of plates forming the condensers. If an electrostatic voltmeter, therefore, be connected across the capacity $C_2$, its reading bears a constant ratio to the P.D. between the mains, and by varying $C_1$ and $C_2$ any desired ratio may be obtained. Several advantages, such as

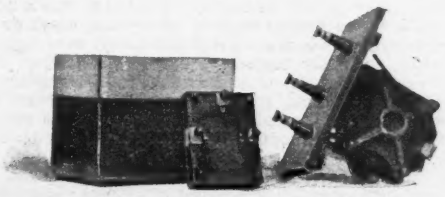


Fig. 3.

compactness and saving of material, are gained by forming the two capacities into a condenser, in which one of the two sets of plates is itself divided into two groups, each group connected to its own related main, one group to the voltmeter, and the voltmeter again to the undivided set, as in fig. 2.

Two instruments have been constructed up to the present on the principle described; one suitable for measuring P.D.'s up to 300 volts on a 150-volt instrument, and having a ratio of $\frac{1}{2}$, and the other suitable for P.D.'s up to 10,000 volts, having a ratio of $\frac{1}{100}$. Fig. 3 is an illustration of these instruments. Fig. 4 is a diagram showing the arrangement of the low-tension instrument. This is formed of alternate sheets of mica and tinfoil of equal dimensions respectively, held together between strong plates of ebonite. Fig. 5 is a diagram showing the arrangement of the high-tension instrument. This is similarly formed, except that copper-foil is substituted for tinfoil, the dielectric varies in thickness directly with the tension, and the whole is clamped between brass plates. The

Fig. 4.

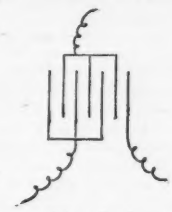


Fig. 5.

dielectric plates in the higher-tension portion are made larger than those in the lower-tension portion to avoid sparking over the surface, and the entire instrument is suspended in oil for the same reason. The accuracy of the apparatus made has been tested by careful experiments. The measuring instruments used were calibrated at the time of the experiments by comparison with a Kelvin standard balance, and the P.D.'s for the high-tension instrument were obtained by means of a transformer of known ratio. This ratio was determined at a low P.D., and found to be 55·42 and assumed constant; thus the actual voltage in all cases given below is that measured on the primary multiplied by 55·42.

### Results of Experiments.

*Low-Tension Instrument.*

| Total P.D. between mains. E | Reading of voltmeter. $V_2$ | Ratio $\frac{E}{V_2}$ |
|---|---|---|
| 139·9 | 73·4 | 1·906 |
| 149·3 | 77·7 | 1·921 |
| 162·4 | 85·1 | 1·908 |
| 174·7 | 91·0 | 1·920 |
| 185·9 | 97·2 | 1·912 |
| 196·0 | 102·5 | 1·913 |
| 204·1 | 107·8 | 1·893 |

*High-Tension Instrument.*

| Total P.D. between mains. E | Reading of voltmeter. $V_2$ | Ratio $\frac{E}{V_2}$ |
|---|---|---|
| 6,761 | 174 | 39·48 |
| 7,426 | 186 | 39·92 |
| 7,980 | 204 | 39·12 |
| 8,534 | 213 | 40·09 |
| 9,089 | 231 | 39·34 |
| 9,643 | 243 | 39·68 |
| 10,197 | 259 | 39·75 |
| 10,751 | 268 | 40·11 |
| 11,305 | 283 | 39·94 |

The ratios given above in all cases differ by less than 1 per cent from their mean value, and in most cases agree much more closely Any variations that exist are well within the limits of experimental error. It is hoped that this device may be of considerable practical utility, not only in simplifying the construction of high-tension voltmeters, but in laboratory and experimental work, where it frequently happens that measurements of potential have to be made with voltmeters, the best parts of whose scales are too low. The invention has been provisionally protected.

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In the discussion which followed, Prof. Ayrton said that the use of condensers in series with voltmeters was well known. It seemed to him that a second condenser of large capacity was unnecessary. What would arise due to the variation in capacity of the voltmeter was simply got over by calibration.

Prof. Marchant said they had tried the arrangement suggested by Prof. Ayrton, but the smaller the capacity, the higher the insulation resistance had to be; therefore, if they used a smaller capacity, they had to get a much higher insulation. The second reason was, they wanted to use the instrument for low voltages as well as high.

Mr. Worrall remarked that by the combination they had suggested one maker could turn the instruments out, and they could be used on other makers' voltmeters. One had only to alter the scale and multiply by the numbers. Hence the very slight cost far more than compensated for the extra cost and trouble of calibrating the instrument.

Prof. Ayrton thought the authors would facilitate an easy understanding of the paper if they were to describe their device as putting two condensers of known ratio in series with one another and applying a low-reading electrostatic voltmeter across the terminals of the larger condenser, for then the method would be exactly analogous with dividing a resistance into two parts of known ratio,

and putting an electrostatic voltmeter across the terminals of one, the terminals of one portion while the entire potential difference to be measured was maintained between the ends of the entire resistance.

## THE BERLIN LIGHTNING EXPRESS RAILWAY TESTS.

The experiments now in progress in connection with high-speed electric railway working in the vicinity of Berlin have naturally attracted considerable attention throughout the world, and it may, therefore, be interesting to make further reference to the subject. It should first be stated that the incentive to the trials is attributed to Herr Wilhelm von Siemens, and hence to the Siemens & Halske Co. Indeed, the latter is said to have recognised early in the eighties that the employment of continuous current or of alternating current in conjunction with rectifiers would be commercially impracticable for railway working on account of the heavy cost of the conductors, and recourse was consequently had to rotary currents for the experimental operation of a car at the Charlottenburg works and a second car in the neighbourhood of Gross Lichterfeld in 1888. After numerous trials, a scheme was suggested for the establishment of a company to make experiments in high-speed working, and in 1900 the "Study" Co. for Express Electric Railways was formed with the assistance of the Siemens & Halske Co., the Allgemeine Elektricitäts Gesellschaft and others interested in the subject. The object of the company, which was to ascertain the possibilities of electric traction for main-line service, and to endeavour to attain a speed of 125 miles an hour, has been accomplished in a highly creditable manner. It should, however, not be overlooked that the idea of connecting together two distant towns by means of a high-speed electric railway is not new. It was suggested, in fact, as far back as 1891, on the occasion of the electrical exhibition at Frankfort-on-the-Maine, when a scheme was proposed for the construction of a high-speed electric railway between Vienna and Buda-Pesth, and, as a remarkable coincidence, the speed contemplated for that line was 125 miles an hour, or the same rate as subsequently projected by the German company which is now conducting the trials.

As far as the commencement of the experiments is concerned, it may be remembered that the Prussian State Railway Administration placed at the disposal of the Study Co. the military railway between Marienfeld and Zossen, near Berlin, the line being 14¼ miles long, and practically level, and only having two curves, which are of considerable radius. The early trials, which were made with two locomotives, built respectively by the Siemens & Halske Co. and the Allgemeine Elektricitäts Gesellschaft, were successful in so far that a speed of 100 miles an hour was achieved by both locomotives. It was, however, found necessary to suspend the experiments as the permanent way, as mentioned in the Electrical Review of October 2nd, 1903, was pounded to pieces, and further trials were out of the question. Since then the Prussian Government has had the line reconstructed at considerable expense, partly for the purpose of the electric railway tests, and partly for the trials which are yet to be made of the capabilities of improved types of steam locomotives. Some particulars of the heavier track, together with the laying down of guide rails, were given in the issue of this journal which has already been cited. In addition to having a new track, it was considered advisable to make alterations in the locomotives, and both of these have been partially reconstructed, especially in regard to the bogie trucks. The work in this direction was carried out by the companies concerned, but the reconstruction of the Siemens locomotive was completed much earlier than that of the A.E.G. locomotive, and this is the explanation for the trials being resumed by the former a few weeks in advance of the latter. The following figures show recent performances of the cars:—

Siemens Locomotive.

| | |
|---|---|
| September 23rd ... ... ... ... | 108 miles an hour |
| „ 26th ... ... ... ... | 117 „ |
| October 23rd ... ... ... ... ... | 129 „ |

A.E.G. Locomotive.

| | |
|---|---|
| October 21st ... ... ... ... ... | 106 miles an hour |
| „ 24th ... ... ... ... ... | 112 „ |
| „ 28th ... ... ... ... ... | 131 „ |

It is thought that even if a high speed electric railway should not be built in Germany, the results of the trials will exercise some influence upon the shaping of transportation methods in that country, and at the same time largely increase the competitive capabilities of the German electrical engineering industry as a consequence of the actual fulfilment experimentally of the calculations and object set forth at the commencement. Herr J. Kollmann, who was one of the guests conveyed by the A.E.G. locomotive, when it made the record run, and attained a speed of 131 miles an hour, states that the trials have shown that contrary to the assumption entertained hitherto, the resistance offered by the air to the train remains directly proportional to the square of the velocity, even in the case of the highest speeds, and that it would, therefore, be possible for the train to attain the same high speeds, even when strong winds were blowing. The A.E.G. locomotive, which weighs 93 tons, and is equipped with the Westinghouse brake, exhibited the undermentioned acceleration on the record journey accomplished on October 28th, after leaving Marienfeld *en route* for Zossen:—

| Distance run. | Speed attained. |
|---|---|
| 3·10 miles ... ... ... ... | 90 miles an hour. |
| 5·89 „ ... ... ... ... | 125 „ |
| 8·50 „ ... ... ... ... | 131 „ |

The speed of 131 miles an hour was maintained for 10 seconds, when the current was switched off and the brake brought into operation, the locomotive being at that moment 5·33 miles distant from Zossen. Shortly before reaching this terminal station a speed of 37 miles an hour was recorded, and this was quickly braked down. It is calculated that if, on switching off the current, the locomotive had not been braked, and the railway had been longer, the car would have travelled at least 21 miles on the level before coming to rest. The whole distance between Marienfeld and Zossen was traversed in eight minutes, this corresponding to an average speed of 108 miles an hour. As is tolerably well known, the operation of the locomotives is effected by means of three-phase currents supplied at 10,000 to 14,000 volts, and collected from overhead wires by means of bow or similarly shaped collectors. The consumption of power in the case of the A.E.G. locomotive on the record run amounted to no less than 2,300 kw. during the period of acceleration, whilst as much as 1,000 kw. was still required to maintain the locomotive at its highest speed when this had once been reached. This shows, on the one hand, the enormous requirements of the locomotive before attaining its top speed; and, on the other, the widely varying load placed upon the generating station for a single engine. It is possible at the highest speed to distinguish tolerably well the district traversed and to observe the signals in clear weather, but the question as to the kind of electrical or acoustic signals for use in unfavourable weather does not appear to have been considered down to the present time.

The trials, with the exception of one or two insignificant mishaps in connection with the supply of current, have been exceedingly successful, but it is improbable that any attempts will be made to attain higher speeds than those which have already been accomplished by the two locomotives. In fact, it is considered that speeds of over 100 miles an hour are of no value for practical railway working, and the further tests will therefore be restricted to about that rate in order to enable scientific observations and measurements to be taken so as to enable calculations to be made for the application of the results of the experiments in every-day service. Until these have been completed it would be advisable to accept with considerable reserve the reports circulated respecting proposed high speed electric railways between Berlin and Hamburg and between Berlin and other towns. Rumours of this character have been published at different times during the past year or so, but they have proved equally as unfounded as are the reports in circulation at the present time.

## ROYAL COMMISSION ON LONDON LOCOMOTION.

This Commission resumed its sittings on the 6th inst. at the Westminster Palace Hotel, when evidence was given by Mr. W. E. Riley, architect to the London County Council. He said that when the municipality of Paris began to scheme a system of direct communication for that city, it adopted as a basis of consideration the underground railways of the County of London. A unified and complete system had been evolved and worked out in detail. The system which formed the model for the Paris system was that which, to some extent, hampered the adoption of any ideal scheme in London, viz., the inner and outer circles of the Metropolitan and Metropolitan District lines. He suggested that an ideal scheme would be one giving circumferential lines at various distances apart, and crossing these diametrically by other lines running across the County, and joining the circumferential lines with the centre points. The existing and authorised electrical systems, of which only the North-West London and City to Brixton tubes were not now in course of construction, were made up of a series of irregular lines which, as at present arranged, did not constitute a unified system. In order to further improve the system, broad avenues converging towards the central areas of the County were suggested, which would materially increase locomotive facilities. These avenues would provide for underground, as well as surface locomotion. The underground systems of all the diametrical lines, both tube and shallow underground, might be looped at the outer ends, as in the Paris system, in order not to obstruct possible future extension.

Dealing with the question of locomotion extensions outside the central area, witness said that the test of efficiency would be the conveyance of the working and business population, and, if this were accomplished, the requirements of those who travelled in the same direction during the less busy hours of the day, would be covered. The inadequacy of some of the existing railways to cope with suburban traffic was well known, and, amongst others which were badly overcrowded, might be mentioned the Great Eastern, the North London and the City and South London lines. In some cases that congestion could be remedied by the construction of new lines; and in other cases by widening the existing lines. As a general principle he would suggest that passengers should be conveyed from outlying districts by lines radiating from the central

area to the county boundary. Such lines might advantageously, where possible, be continued across the central areas in the direction of the opposite boundary, or run into exchange stations at which passengers could conveniently continue their journey. Apart from its equipment, the City and South London line afforded an instance of a direct route to a central exchange point and of a line continued across the central area into the outlying zones. Mr. Riley gave a list of additional routes which were required. Great advantage would be obtained by additional communication between the districts north and south of the river, and to complete the system by connecting one district with another, certain points on the various radial lines should be selected and locomotion services provided between the points. The particular kind of connecting service, whether omnibus, tramway or railway, most suited to the needs of the various localities, would probably, he thought, form the subject of consideration by the tribunal which might be established, and by the L.C.C. as the tramway authority. Deep level tubes should only be constructed where street traffic rendered it impossible to construct shallow underground railways or surface tramways. Connections should be made between tramways, which at present terminated near the county boundary, with other systems just beyond the county. With reference to tramways in the main thoroughfares, the accelerated speed obtained by the introduction of electric motive power, and the greater carrying capacity of the cars, would induce greater numbers to travel by tramway, to the diminution of the horse omnibuses and to the corresponding relief in congested roadways in certain directions. The popularity of the system would also add to the number of cars, and, probably, marshal the traffic in crowded and narrow thoroughfares, and might necessitate expensive street widenings.

Witness then explained a scheme for the construction of broad avenues in various parts of London for the purpose of providing relief to the rapidly increasing street traffic. He remarked that the lines of such new thoroughfares would have to be chosen so as to pass through inexpensive property, and he believed that by acquiring sufficient property on both frontages and providing for surface tramways and shallow tubes, a return would be obtained for the necessarily heavy outlay which these avenues would cost the ratepayers.—The Commission adjourned.

## EDUCATION AND SCIENCE.

Prof. Armstrong, one of our chief organic chemists, and one of our most distinguished teachers of chemistry, has contributed to the current issue of the *Quarterly Review* an article somewhat on the lines of Sir William Ramsay's recent letter to the *Times*, and Sir Norman Lockyer's address to the British Association. Beyond quoting two of Dr. Armstrong's sentences, which are virtually the texts of his argument, we do not propose to paraphrase his article, leaving it to be read in the original; but, to indicate his standpoint, we give those sentences: "Our failure is due to the fact that our manufacturers, though business men, so-called, know nothing of science, and have no sympathy with it." "The so-called business man is out of his depth in our country at the present day," the reason for this being our "defective system of general and secondary education, including university training."

The plain fact of the whole matter is that, if the overwhelming majority of our fellow countrymen are ignorant of what is meant by "science," they are equally ignorant of what is meant by "education." The average citizen brings children into the world, and if he earns enough to keep them and send them to school, he considers that he has done his whole duty by them. Thus he leaves the schoolmaster to fulfil duties which he and his wife ought to undertake—duties which even the most efficient schoolmaster cannot perform so efficiently as intelligent and honourable parents, living their daily lives at home under the children's eyes. The wife of the middle-class household considers the elementary school as a labour-saving device, its staff as a combination between playmates and nursemaids; the husband views it as a deputy father, whose function it is to inculcate truthfulness, obedience, and all the rest of the necessary domestic and social virtues. A few years later he regards the primary school as a place where children shall be taught calisthenics to improve their general health, and a few specialised "subjects," a superficial facility in which may enable the youths to earn a living. To some extent the schoolmaster is to blame for accepting the position thus thrust upon him; but even if he were, or believed himself to be, capable of performing these duties efficiently, he is undoubtedly to blame for not pointing out that this is not education, but a mere waste of that time which he might otherwise devote to educational processes.

What, then, is education? According to Prof. Armstrong, it is the "manufacture of intelligence." In that extremely suggestive book published a short time ago entitled "Mankind in the Making," Mr. H. G. Wells defines the "business of the school" as a "widening of the range of intercourse." The ideal schoolmaster is not wanted to develop a boy's muscles or his social, moral, or religious character; not even to peck into his brain facts, figures or "subjects," but to stimulate the curiosity latent in every child into a thirst for knowledge, to encourage in him a love of reading and original investigation, and to help him to attain a power of discrimination between what is good and what is bad in intellectual matters. It is of no particular value for a boy to be taught that Charles I. was beheaded in 1649, and that William III. came to the throne in 1689; but a clear presentation of (or an indication of the most trustworthy books explaining) the causes and effects of the two depositions of the Stuart monarchs teaches much. A bald statement of the fact that 1·1837 grammes of cupric copper is deposited electrolytically by a current of 1 ampere in 1 hour is a waste of time if forgotten, and a useless encumbrance of the brain if remembered; but an explanation of the relationships existing between the laws of thermo-chemistry and electro-chemistry, of which that fact is one example, is valuable.

Many improvements have been effected of late years—at least, in the department of elementary education—although, as Prof. Armstrong says—men who have control of education have little or no expert knowledge of the subject. Mr. Wells says that only elementary schoolmasters know how to teach. It may be so; and yet the Board School boy, free as a "young person" under the Factory Acts, who, fully remembering that 28 lbs. make 1 quarter, and 4 quarters make 1 cwt., could not deduce the number of lbs. in 1 cwt., is only typical. Moreover, he is taught to read, and he reads voraciously—not good books of information, adventure or real wit and humour, but the futile "penny-dreadfuls" of to-day, and the so-called "comics," at which he is never seen to laugh. The truth of the matter is that he has not been taught his mother tongue, the large vocabulary of good authors is outside his ken, and simple grammar is beyond him.*

We have spoken of elementary education only, but its phenomena are reproduced in all the stages of our educational processes. Throughout, facts tend to be taught instead of principles, "subjects" instead of methods of studying subjects; arrears from the previous stage have to be overtaken, and time is also wasted in dealing with wholly extraneous matter. Mr. Wells's vein of satire leads him to say that our universities are only just discovering the printed book, for they lecture on subjects that might be better understood by properly-directed reading.

Every time some process new to our commercial men becomes a matter of industrial interest, those who are behind the scenes see repeated the same inevitable cycle of operations. Each manufacturer thinks he has got hold of something absolutely novel, for, possibly, he has looked into the "practical books written by practical men" in our language, and found nothing therein. He does not understand, or is not willing to admit, that the principles underlying the new process are almost identical with those which govern other processes. He will not seek men of "science" to inquire how far they can advise him by the aid of their general knowledge of principles—understanding nothing of the subject himself, he fancies everybody equally ignorant. As a rule, he will not even pay men of trained intelligence to make investigations for him; but prefers to do his pitiful experimenting himself in strict secrecy, knowing neither how to experiment nor how to read the results he gets. After some three or four years' more or less irrelevant work; after, it may well be, some public failures which have brought his industry into disrepute, he succeeds in establishing a rule-of-thumb method of procedure based, albeit unwittingly, upon laws understood in the laboratory before he entered upon the trade. Others, however, have been experimenting too, perhaps under better guidance and more successfully; but he is unaware of this, and so he considers and proclaims himself the only authority or sole maker of trustworthy plant. He has squandered much time and money, which would not matter so much if his rivals were all of the same nation; but not having engaged highly-trained assistants, and having only a narrow "range of intercourse" of his own, he has prevented men of science from putting their knowledge to the service of the country, and he has not even been able to study the advances that have been made abroad. It astonishes him much to learn three years after date that what he has painfully discovered has already been laid down by a contemned "expert;" and it surprises him still more to read that the whole industry is in a much more advanced state in a foreign country than in the land where he views himself as a world-wide "pioneer."

## THE PEAT FUEL PROBLEM.

According to statistics, there are 2,830,000 acres of peat bog in Ireland, of which area the red bog occupies 1,576,000 acres, and has a depth of 25 ft. An engineer who has studied the question assumes, in round numbers, 1 million acres 40 ft. in depth, and having dried out some peat samples, states that there might be garnered 20 million tons of dry fuel for 400 years. If Ireland were sunk under a heavy load of sand and dirt, no doubt this peat would become coal; but it is necessary for Ireland's development that something should be done to-day rather than that a few millions of years should be allowed to roll on, which the geological tortoise would require.

Peat is a substance that is hard to dry. It soon dries superficially, but the inner part of only a 6 in. cube dries out very slowly even in a hot oven. To prepare peat for fuel, it appears necessary to disintegrate it and dry it. In the electrical process, of which an exposition was given at the works of Messrs. Johnson & Phillips, at Charlton, on Thurs-

* In one of the London parks may be seen a printed L.C.C notice: "... any person whomsoever ... is liable to a penalty ..." And the L.C.C. is an educational authority!

day last week, the peat is placed in centrifugal drivers, which drive out, it is said, most of the 80 per cent. of water which exists in the peat. Electrodes are inserted, to which current is supplied from a dynamo, the peat mass completing the circuit, and its conductivity being assured by the addition of certain chemicals. The resulting mass is then placed in a machine like a dough mixer, in which, by means of the revolving blades, it is rolled and kneaded into a plastic condition, after which it is passed on to a briquette machine.

The effect of the electrical treatment is claimed—erroneously, we think—to differ from ordinary heat application in that it ruptures the cellular fibre and helps to final consolidation. In the description of the process which was handed round in print, we were given to understand, though the language are very ambiguous, that this electrical heat dried out the peat.

We were too distant to hear Mr. Carmichel's speech, but were informed that he did not stand by this claim, but confined himself to claiming a rupturing of the cellular tissue by the electrolytic action. We endeavoured to elicit from him how many units of electricity were required per pound or per ton, but we were unable to secure this information; Mr. Carmichel suddenly left us in the middle of our questioning, and all we were subsequently able to ferret out was that a current at 200 volts averaging 100 amperes for 20 minutes—it commenced at 230 amperes—was passed through a very small quantity of peat in the centrifugal cylinder.

The mechanical apparatus which we saw was purely experimental, and therefore we find no fault with it. We believe that peat is only to be dried economically by centrifugal machines, and that while the peripheral speed of a 4 ft. 6 in. machine at 1,000 revolutions may produce dryness, it is hopeless to expect a good result from a 2 ft. 6 in. cylinder at only 300 revolutions, as was seen.

But this we pass by. It must, however, in fairness to the possibly investing public, be pointed out that one unit of electricity cannot generate more than 3,410 heat units when passed through wet or damp peat, and that probably any rupturing effect is small or purely imaginative. To produce one unit of electricity requires 3 lbs. of good coal or a potential calorific power of 45,000 B.Th.U., or thirteenfold the heat potential of the electrical energy it generates. Even if there is more in electrical peat than in electric sugar, we very seriously doubt the value of any process of peat treatment which involves so heavy an expense as must be incurred in generating so much electricity for so small a product of peat.

The demonstration was no real demonstration at all, for there were no figures given. Little damp briquettes were brought from somewhere and handed round. How are the briquettes to be dried? The only principle of value was the centrifugal drying, which is not new. We cannot afford to place any value on the electrical process, and nothing was seen to induce an engineer to suspect that it has any value.

Assuming that peat contains 80 per cent. of water as stated, and we have known it even wetter than this, it is essential to dry it mechanically, and on this score it seems to us to make very little difference whether the fresh peat is only half water or is nine-tenths water, for it is the last of the water which clings. The bulk can be rolled out or driven off centrifugally.

The one essential to the success of the peat fuel industry is, however, the economical gathering of it. The present system of harvesting peat is most crude. It consists in cutting it by a special tool like a fenman's spit. The soppy peats are piled in low openwork heaps to stiffen and dry in sun and air. They are then carried home in creels by asses, children, old men and women, and are stacked and thatched. As an industrial process this procedure is impossible, and the success of Ireland's peat industry cannot be assured until the means of harvesting are placed on a sound mechanical basis.

We believe that as much technical success would attend the process shown us if the peat were heated by steam or by direct furnace gases as by the wasteful electrical process. It would be a pity for this electrical process to be put forward and prove, as we think it must prove, a failure. Ireland has already suffered much from badly-considered inventions. The peat industry has been kept back by the paltry, inefficient and unscientific methods so far employed. On the face of it, does this electrical process appeal to common sense? One unit of electricity is said to electrolyse water to form 166·6 litres of hydrogen, or 0·015 kgm. per unit, representing 0·135 kgm. or nearly 0·3 lb. of water. It is not reasonable to ask belief of the extensive electrolytic effect of any reasonable amount of electricity, costing several pounds of dry peat fuel to produce it even by gas producers and gas engines.

The demonstration was attended by a very great crowd of pressmen generally. Everything was too crowded. It would appeal to engineers far more to have a test in the presence of a dozen technical men with absolute figures of cost, &c. We were finally informed that a plant is to be erected in Ireland immediately.

Three of the sample briquettes already partly dried we found to dry out nearly 10 per cent. in an ordinary living room in 60 hours. They were then hung in tape for 8 hours before a small fire, and showed a total loss of 20 to 25 per cent., with every appearance of drying out finally to about half their original weight.

We understand that Messrs. Johnson & Phillips have no interest in this process, their works being merely used for the purpose of the demonstration.

## NOTES ON THE THEORY OF PARALLEL RUNNING OF SYNCHRONOUS MACHINERY.

By H. C. LEAKE, A.M.I.C.E.

The paper entitled "The Parallel Working of Alternators," read before the British Association by Mr. B. Hopkinson, an abstract of which is given in the Electrical Review, October 9th, contains a very clear exposition of what may be termed modern views on the theory of parallel running as contrasted with the treatment given in many text-books, papers, and articles of recent years. The paper contains, however, one case of unfortunate choice of wording which I cannot but think is an oversight, but which is liable to mislead anyone not closely acquainted with the subject. Mr. Hopkinson states that the practical rule adopted by designers is "that the angular displacement of the machine in a revolution when running unloaded as compared with an uniformly revolving wheel shall not exceed a certain fraction of the angular pitch of the poles." I would suggest to Mr. Hopkinson that to bring this statement into accordance with ordinary practice, the word "unloaded" ought to be changed into "at any load," and, further, that it should be explained that when calculating the angular displacement of a given engine, it is invariably assumed that the torque of the load is constant throughout the revolution, *i.e.*, the assumed load is of a very different nature to the load the engine will have to work against in practice. A similar misuse of the word "unloaded" occurs also a little later on in the paper.

Mr. Hopkinson's remarks on what I will follow him in referring to as the "practical rule" are not, in my opinion, sufficiently strong. In an article which I contributed to the Electrical Review for April, 1902, I showed, by means of a diagram, that the fluctuation in rate of flow of energy due to an uneven turning moment was by no means limited to any particular value by following the "practical rule," and I came to the conclusion that this rule ought to be discarded entirely, and that, in place of this, attention should be directed to the amount of fluctuation in rate of flow of energy when the set was working under ideal conditions as regards bus-bar potential difference. In order to carry out this method of design practically, it would be necessary to have at hand numerical data of machines of a sort which, as far as I know, have not yet been published. In the article referred to above, I gave a set of curves which, if determined experimentally for any particular synchronous machine, will yield the data required for this method of treating a certain class of parallel running problems. Unfortunately, to obtain such data from the

large machines which are in common use now is a matter attended with considerable difficulties; but there can be, I think, little doubt but that some such data will be in general use some day, and will receive from those who buy or construct synchronous machinery as careful consideration as is given to data relating to efficiency, regulation, &c.

It is, of course, a matter of common knowledge that satisfactory operation, from the practical point of view, has been obtained on many large plants designed in accordance with the "practical rule," but this is no proof that the rule is correct. Success in such cases must be ascribed rather to good fortune and to untiring effort on the part of those operating the plant than to accurate predetermination and rational design from the point of view of parallel running.

If further arguments against the "practical rule" are necessary, it may be noted that there have been signs recently of a reaction from the use of excessively heavy fly-wheels, which probably implies that the "practical rule" has been found wanting. Indeed, I think that anyone who takes into consideration the experience gained during the last 10 years in the way of parallel running with all sorts of engines and at periodicities varying between 25 and 100, must come to the conclusion that the "practical rule" does not furnish us with a correct method for comparing the parallel running qualities of different engines.

It should not be forgotten that the so-called "practical rule" was originally derived from theoretical considerations and not from practical experience, and there should perhaps on this account be less hesitation felt in throwing it overboard to rejoin the reversing field theory of commutation and other relics of earlier days.

I may also refer here to another point connected with parallel running, which is not dealt with by Mr. Hopkinson, viz., the question of frequency. To fix our ideas, let us suppose that a manufacturer has supplied certain engines for a power scheme at 25 periods, and that the parallel running with these engines is found to be all that could be desired. If now he desires to use the same type and size of engine on another power scheme similar to the former, except that the periods are 50, he will, if he adopts the practical rule as a guide, be obliged to approximately double the weight of his fly-wheel, as it will call for double the moment of inertia in the rotating parts. I believe that there is at present no valid theoretical reason for considering that the parallel running of engines is facilitated by low frequency, and, therefore, there is no reason why the manufacturer should not use the same fly-wheel in both cases. I do not think that practical experience can be said to clearly favour low frequency either.

An expression of the opinion of others on the above point would be of interest. Of course, the question of low frequency in relation to rotaries must not be allowed to confuse the issue. There are well-known reasons unconnected with mere synchronous running why a low frequency is preferable for these machines.

The above remarks on frequency are in reference to the effect of uneven turning moment of the prime movers, and not to the question of free oscillations, and, as Mr. Hopkinson has devoted so much attention to the latter subject, it would be interesting if he would give his views on the subject of frequency in its relation to the stability of free oscillations of synchronous machines.

When hunting is referred to in papers and articles dealing with the question of parallel running, it is often a matter of some difficulty to be sure as to exactly what sort of hunting is being alluded to. There appears to be some confusion as to the nature of the different classes of hunting which are possible, and it may, therefore, be worth while to briefly enumerate them. No doubt in practice the different classes may occur irregularly and simultaneously, and a sharp distinction cannot always be so readily drawn.

As indicators of the magnitude and nature of the oscillations going on in a circuit, the ordinary switchboard instruments are useless, on account of their sluggishness and large natural period. The instrument for this purpose is the oscillograph, and most fascinating it is to watch the working of a machine by its means. The writer thinks that, in the case of a large power station employing current and potential transformers on its switchboard, it would be quite worth while to fit up close to the switchboard a permanent oscillograph room. Small wires connecting the various current and potential transformers with this room would enable the oscillograph to be readily switched on to any generator or feeder, and it is probable that such facilities would prove of considerable value in the operation of a system.

All cases of hunting of a synchronous machine can be classified under the following heads:—

1. Forced oscillations.
2. Free (or natural) oscillations.
3. Oscillations due to governor effects.

The first class covers the oscillations set up by any disturbance, the period of which bears a fixed ratio to the period of alternation of the system. Such disturbances are the cyclical fluctuation of turning moment of a reciprocating prime mover, and the fluctuation of turning moment of a steam turbine when the steam is admitted in puffs, the duration of which is controlled by the governor. In the case of a synchronous motor such a disturbance may be found in the pulsation of periodicity at its terminals due to the above causes.

The peculiarity of this class of oscillation is that the magnitude of the oscillations is not determined only by the magnitude of the initial disturbance, but the time period of this disturbance is of equal importance. The phenomenon of resonance can also show itself. In a case I met with where two engines could never be got to run in parallel, it was found by calculation that the conditions for resonance must have been approximately fulfilled.

Such forced oscillations always exist, although in most cases they may not be of practical importance, except in so far as they involve a loss of energy of an unknown extent. It is not unusual to see every instrument on the switchboards (both A.C. and D.C.) of synchronous sub-stations slightly oscillating in time with the revolution of the engines, although the effect may be so small as not to be distinguished on lamps on either A.C. or D.C. sides. The oscillograph shows that an astonishing amount of periodic fluctuation of current on the A.C. side is not inconsistent with satisfactory operation.

Periodic fluctuation in the turning moment of steam turbines has been mentioned above. This is a point in connection with these prime movers (of the type chiefly in use) which is frequently overlooked, as it is often stated that they possess a perfectly even turning moment. It is worth noting, however, in this connection, that, according to a patent recently issued to the Hon. C. A. Parsons and Mr. Swinburne,* it is found important for good parallel running that the puffs of steam shall be coincident in turbines running in parallel, and further, that if there are reciprocating engines also, the puffs of steam in the turbines shall be coincident with maximum efforts of the cranks of the reciprocating engines. Of course, one advantage inherent in the turbine is that the period of the impulse can be easily varied.

The second class of oscillations are those set up by a sudden change of conditions, such as a sudden change of load, or a bad synchronise when switching in a new machine. Anyone who has spent much time in the sub-stations on large polyphase systems must have met with very audible evidence of these free oscillations. But they are not always noticeable when it would seem that they ought to be. As an example of this, a case may be mentioned where a 250-KW. motor-generator was constantly put on circuit 120° out of phase owing to a mistake in the synchronising connections, but although the machine audibly expostulated in a vigorous manner, one could not hear in the sound the least indication of oscillations. Presumably there really were a few oscillations, but the period was short and the damping great, so that the ear could not separate them.

Until recently it was comforting to think that such oscillations whenever started must soon die out, just as a disturbed pendulum will come to rest, and hence that they could not be of much practical importance, but Mr. Hopkinson, and also Mr. Steinmetz, have demonstrated that this is not so, but that if free oscillations are once started, it is possible that their amplitude may continuously increase until the running becomes impossible. This phenomenon is, of course, quite distinct from that of resonance. It is important to notice that oscillations of this class are absolutely independent of the type of prime mover, and may occur when the turning moments of the prime movers are perfectly free from fluctuation.

As regards the third class of oscillations this is perhaps

* Specification No. 19,031, 1902.

the most complex part of the subject, and one that is very difficult to deal with briefly in a general manner.

The hunting due to governor effects may be of the nature of either forced or free oscillations. For instance, if the governor is in periodic motion during and in time with the revolution, it may affect the proportion between the cylinder pressures in the two strokes of the revolution, and thus by altering the cyclical turning moment curve it may set up forced oscillations. Or, if the governor mechanism itself is executing free oscillations on its own account quite independent of the time of revolution of the prime mover, it may introduce a component of the same period into the turning moment of the prime mover, and thus set up oscillations of synchronous machines which are properly described as "forced," although they have their origin in the free oscillations of the governor mechanism.

Oscillations due to governor effects, however, more often depend on an action of a different sort. The combination of a prime mover, a heavy fly-wheel, and a governor, working on a steady non-synchronous load, form a mechanical system possessing a natural period of oscillation of speed long in comparison with the time of revolution; and these oscillations, if set up, sometimes eventually die out, and sometimes do not. These oscillations, which are easily set up by sudden change of load as when testing governors, are of the nature of free oscillations of a very complicated nature, and, as far as I know, have not been treated theoretically, though I believe it is not in general impossible to predetermine their approximate period in a steam engine. The size of the fly-wheel, the time taken by the steam to pass through the engine, and the exact method of governing are important factors in the case.

When engines are running on synchronous systems such oscillations also take place, but it must not be supposed that the period is necessarily the same as when running on a non-synchronous load, as the conditions are so very different for the engine. Indeed, it is not improbable that the new conditions introduced by the synchronous system may sometimes render it more likely for oscillations of this nature to show themselves.

While it is very useful for theoretical purposes to assume that the potential difference of a system is constant both in amplitude and periodicity, and to calculate natural periods of machines on this assumption, yet it must not be forgotten that in practice the amplitude and periodicity of the potential difference will probably fluctuate periodically to some extent, and that this may make a great difference in the fluctuation of flow of energy resulting from a fluctuation of turning moment. Suppose, for instance, that the system consists of a generator whose natural period is $\frac{1}{2}$ second driving a synchronous motor whose natural period is $\frac{1}{2}$ second, and that the period of fluctuation of the turning moment of the prime mover is approximately $\frac{1}{2}$ second. At first sight it might appear that the conditions for resonant oscillations of the generator as previously described are here fulfilled, but further consideration shows that such oscillations cannot take place in this case, since there is nowhere in the system for the large fluctuation of the current of the generator to be taken up, as the motor will respond but slightly, to a disturbance whose period is so different from its own natural period. What must happen, therefore, is that a periodic fluctuation (of same period as the turning moment) will be set up in the amplitude and periodicity of the potential difference of the system such that the fluctuations of current of generator and motor balance one another, and this result is not, of course, necessarily inconsistent with sufficiently satisfactory operation in practice. If, however, this same generator and prime mover were running in parallel with plant of many times its own capacity, it is safe to say that its running would be very bad, if not impossible.

A distinction may be drawn between the natural period of oscillation of a system and that of a single machine. In the previous example, the natural period of the system consisting of generator and motor would be intermediate between $\frac{1}{2}$ and $\frac{1}{3}$ second.

Complete theoretical treatment of the complicated systems of actual practice is, of course, impossible, but considerable insight and information may be attained by studying them on the lines of the modern theory of synchronous running. This will, at least, ensure that the important matters of periodicity and weight of rotating parts have their influence properly reckoned. As in most cases of oscillatory motion, the calculations strictly apply only when the oscillations are of small amplitude.

Periodic fluctuation in the amplitude and periodicity of the potential difference of a system due to the use of prime movers with uneven turning moment has been referred to above. A glance at the voltmeter is often sufficient to show that periodic fluctuation in the amplitude exists. The writer some time ago endeavoured, by means of the oscillograph, to obtain direct evidence of fluctuation in the periodicity on a large polyphase system driven by slow-speed reciprocating engines. The oscillograph used in the ordinary way will not show such fluctuation, so the oscillograph motor was run from an independent and perfectly steady source, while the strips were connected with the bus-bar potential difference in the usual way. A procession of potential difference curves was thus seen crossing the screen, which, by closely adjusting the speed of the oscillograph motor, finally became stationary. Periodic fluctuation of the periodicity would have shown itself as an oscillation of this curve to and fro sideways, but no sign of such motion could be detected. All that was noticed was a slight periodic change in the shape of the curve. It should be added, however, that when these observations were made the running of the system was perfectly satisfactory as regards the effect of uneven turning moment, and it is quite reasonable to suppose that the periodic fluctuation in the periodicity was too small to be noticeable by this method.

## ECONOMICAL SPEED REGULATION WITH CONTINUOUS-CURRENT MOTORS.

By FRANK BROADBENT.

It is almost impossible to pick up any American technical paper without noticing at least one article referring to the obtaining of wide speed range with continuous-current motors. Many and complicated are the ways and means proposed for obtaining such wide speeds. In the *Electrical World and Engineer*, October, 1903, there appears an article by A. F. Hemingway on the subject, in which he refers to the impossibility of obtaining a design of motor productive of anything like a satisfactory range of variation, and gives it that the practical limit is a speed ratio of about 2 to 1. He is referring to speed range by the variation of magnetic density of the field magnets.

It would appear from a perusal of such articles that English designers and manufacturers are ahead of their American *confrères*, as standard motors can now be bought in the open market in this country in which a speed regulation of 2 to 1 can be obtained by means of a shunt rheostat control. Nor is there any difficulty, apparently, in obtaining the ratio of 3 to 1 by the same means, and there are many motors driving machine and other tools in which this range is normally obtained. The cost of such a motor is, of course, greater than one in which no speed variation by shunt control is required, as the motor must be large enough to develop the maximum power required at the slowest speed. But, on the other hand, such special designs of machines as are indicated in Mr. Hemingway's article, in which double-cored armatures and auxiliary magnets are required, would probably cost more than a plain shunt-wound motor large enough to give the full range of speed required. The other methods for obtaining speed control, such as multi-voltage control and similar special systems, although probably not increasing the cost of the motor itself, increase the cost of the installation as a whole, and also considerably increase the cost of upkeep. It should not be overlooked that simplicity has a commercial value. These efforts to obtain economy in speed regulation by complicated and special motor windings are perhaps justifiable for special cases; but for the general run of work, they are quite unnecessary.

With standard motors and switchgear there is scope for considerably more economy in working than is often found in motor-driven works.

One frequently comes across motor installations, where

speed control and economy are desiderata, in which the whole range of speed is effected by plain series regulators. We have instances in mind in which approximately 30 motors are controlled in this way, and the driving arrangements are such that in some cases the top speeds are never, and in most cases rarely, used. A constant waste of energy is thus going on, which, with a little scheming, could have been avoided.

In one installation something like £150 is thrown away in an annual bill for electrical energy amounting to about £500. To strain after an increased efficiency of 1 or 2 per cent. in the motors, and then neglect obvious means of saving 25 per cent. in the general economy of the system, is, of course, a very false sort of economy, but is really no worse than asking for an increased lamp efficiency of half a watt per candle, and then wasting half the light by bad distribution.

Very wide speed regulation is not required as a general rule for either machine tools or small printing machines—that is to say, a range of more than 2 or 3 to 1. A range of 2 to 1 would cover most cases. There is no reason, therefore, to adopt any complicated and expensive system in such cases as these, nor to put down a "freak" motor instead of a standard machine.

Newspaper printing machines do, of course, require a very wide and uniform control, and to obtain this electrically involves a somewhat complicated arrangement, but there seems to be rather a tendency in the American technical press to overdo the question of speed control for ordinary work, and to boom special systems.

## THE BROADNESS OF THE ELECTRICAL ENGINEERING PROFESSION.

By E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E.

It is one of the fascinations of electrical engineering that one never knows what one may have to do next. Some day, no doubt, when the profession has grown out of the infantile stage our irritating friends are so fond of quoting, we shall all be chained up each in his corner, and lead regular if monotonous lives. In the meantime, however, the man who has spent most of his life amongst heavy machinery may at any moment be called upon to design delicate electrical instruments, or, after years in manufacturing, take to advising town councils professionally. It is just as likely he may have to tackle an entirely novel electro-chemical problem or undertake track construction for a tramway or railway, or carry out the hydraulic work of a transmission of power scheme. In fact, at the present time it is impossible for the electrical engineer to have too broad a knowledge, and the younger men would do well to bear this in mind. One very important thing which is almost entirely overlooked in the training of engineers is an acquaintance with commercial affairs. There are several examples of successful men whose principal claim to their position in electrical engineering appears to be that they can juggle with Board of Trade accounts, or talk wisely of the financial side of affairs; and such is the power of the dollar end of the business, that they are even admitted as full members of the Institution. The young engineer would do well to make a note of this, for, after all, his main object is to make a decent living, and it is certain that if he doesn't look after the commercial end as well as the technical, he will be liable to get left by the purely commercial man. For example, it is well known that the City is full of a guinea-pig class, which fattens by the exploitation of engineers who are so busily interested in the technical end that others take most of the bawbees.

During the winter months which are now upon us, most young engineers use their leisure time in study or attending evening classes, or at any rate, they ought to. It does not follow that the classes should be on engineering; in fact, for one who has been grinding engineering all day, it is better to take up some entirely different subject. Amongst others, the writer would recommend some of those included under the Chamber of Commerce and Institute of Bankers' examinations, such, for example, as commercial law, banking, &c.

Again, for those who have artistic tastes, there are numerous art classes, and in this connection it may be worth mentioning that the really successful designer must have imagination, and be something of an artist. The success of certain prominent dynamo designers is a good deal due to their having a strongly-developed artistic temperament. Again, the budding electrical engineer will not improbably, at some time or other, have to prepare advertisements or compile catalogues. This may appear easy, but, as a matter of fact, it wants doing, and a well trained artistic sense will come in most usefully. We are so utilitarian and matter of fact, that we are apt to associate everything of an engineering nature with harsh lines and the severest simplicity. In this respect we lag behind competitors abroad, as witness the magnificent catalogues of the German firms and the arresting and pointed advertisements of the Americans. (By the way, the writer has not in mind those pictures of winking cats used to advertise certain engineering specialities in the States.)

There is still another direction in which the budding engineer would do well to get some training, and that is in public speaking and the art of debate. Other things being equal, the man who can express himself concisely in public, and can make a ready reply or comment during a discussion, will have the advantage. Some members of the profession have been quick to see this, and make up for lack of technical knowledge by ready and witty speech. They may be said to have too much signboard and too little warehouse.

## THE SPEED OF TRAMCARS.

[FROM A LEGAL CORRESPONDENT.]

The action of certain persons interested in motor-cars, who view with a certain degree of *schaden freude* the immunity of electric tramway companies from prosecutions for furious driving, has recently given rise to a series of experiments for the purpose of showing whether these vehicles can exceed the legal limit of speed.

This is a question of fact—to be determined by experts; our present purpose is to draw attention to the laws which regulate the speed of tramcars, and to inquire whether, wholly apart from any special legislation which may have to do with tramcars, the tramcar is subject to the ordinary laws of the realm which control the use of vehicles on highways.

To begin at the beginning, it is provided by Sec. 46 of the Tramways Act, 1870 (an Act passed, be it observed, before electricity as a motive power was seriously thought of) that:—"Subject to the provisions of the special Act authorising any tramway and this Act," the local authority of any district in which the same is laid down may, from time to time, make regulations as to the following matters (*inter alia*):—

The rate of speed to be observed in travelling upon the tramway.

For better enforcing the observance of all or any of such regulations, it is made lawful for any such local authority to make bye-laws, provided that such bye-laws are not repugnant to the laws of that part of the United Kingdom where the same are to have effect. Such bye-laws must also be subject to the approval of the Board of Trade.

The effect of this provision is that the rate of speed authorised by the bye-laws is not to exceed that which is permitted by the regulations published by the Board of Trade. Thus, by Sec. 23 of the usual form of Tramways Orders Confirmation Act, it is provided that the provisions of the Tramways Act, 1870, relating to the making of bye-laws by the local authority with respect to the rate of speed to be observed in travelling on the tramways, shall not authorise the local authority to make any bye-law sanctioning a higher rate of speed than that authorised by the Board of Trade regulations at which engines are to be driven or propelled on the tramways under the authority of this order; but the bye-laws of the local authority may restrict the rate of speed to a lower rate than that so authorised.

In making regulations with regard to the speed of trams propelled by steam or any mechanical power, the Board of Trade make special reference to the places where the speed may be increased or must be diminished. Thus, Sec. 4 of the regulations is in the following form:—"The speed at which such engines and carriages shall be driven or propelled along the tramways shall not exceed the rate of [eight] miles an hour, and the speed at which such engines and carriages shall pass through facing points, whether fixed or movable, shall not exceed the rate of [four] miles an hour.

If the driver of a tramcar exceeds the limits laid down in the Board of Trade Regulations, he renders his company liable to proceedings for penalties not exceeding 40s. for each offence, with or without further penalties for continuing offences. But this is not the limit of his liability. A tramcar passing along the high road is subject to the ordinary laws which regulate the speed of vehicles on

the highway; and it must not be thought that because a tramway is worked under statutory powers, the company are excused from action for negligence and nuisance to which they might otherwise be exposed. In Sadler *v.* South Staffordshire and Birmingham District Steam Tramways Co. (1889) (23 Q.B.D. 17), an accident was caused by the company's car, which ran off the line at a point where the company's line joined the line of another system, over which the company had running powers. It ran off the line owing to a defect in the points at the place of junction, but it was not clear whose duty it was to repair the points. It was held that in any event the owners of the cars were liable, because their statutory powers did not extend to authorise their running along the highway on a track which was in a defective condition. Again, in Marfell *v.* South Wales Railway Co. (1860) 8 C.B. (N.S.) 535, a railway company owned a tramway which at one point crossed their line. They maintained gates at that point, but never closed them. It was held that they were liable to the licensee of the tramway for the loss of his horse, which was due to their neglect to keep the gates closed, on the ground that the licensee had a right to expect that the gates should be properly managed, and it was the company's duty to manage them. Again, in the Dublin United Tramways Co., Ltd., *v.* Fitzgerald (1903, A.C. 532), a tramway company were held liable for injuries caused by the worn and slippery condition of their track.

The crucial point, however, is to consider whether tramcars are within the statutes passed to prevent furious driving on highways. Thus the Highways Act, 1835 (5 and 6 W. iv., c. 50), Sec. 78 is directed against furious driving, and applies to "any person . . . . driving any sort of carriage." In Taylor *v.* Goodwin (1879) 4 Q.B.D. 228, carriage "will include any which might be propelled at such a speed as to be dangerous," and in Cannan *v.* Earl of Abingdon (1900, 2 Q.B. 66) it was said to include any mechanical contrivance which carries weight over the ground in such a way that the foot of man does not support it. It is obvious that tramcars come within these definitions, and that drivers of tramcars are subject to the penalties imposed by Sec. 78 of the Highways Act. Further, it would, in our view, be competent for a magistrate hearing any charge under that Act to refuse to pay any attention to the bye-laws for the purpose of deciding whether or no there had been "furious driving." At the same time, it would be incumbent upon the prosecutor to elect which statute he should proceed under, for an acquittal upon a charge of infringing a bye-law might well be pleaded in bar to a subsequent prosecution under the Highways Act.

## NEW PATENTS APPLIED FOR, 1903.

**Compiled expressly for this Journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.**

23,102. "Improvements in and relating to the application of electricity for the production of scenic effects at theatres and other places of entertainment." J. F. Carey. October 26th.

23,103. "Improvements in and relating to the application of electricity for the production of scenic effects at theatres and other places of entertainment." J. F. Carey. October 26th.

23,110. "Improvements in electric potential governors." T. L. Boyden. October 26th.

23,120. "Storage battery plates." J. Bijur. October 26th. (Complete.)

23,151. "Improved method and apparatus for producing a suitable circulation of the electrolyte in electrolytic processes." H. Koller and P. Askenasy. October 26th. (Complete.)

23,161. "Improvements in electrically-heated handles." R. A. Fliess October 26th. (Complete.)

23,173. "Improvements in protecting devices for parallel feeders used in the distribution of electrical energy." L. Wilson. October 26th. (Complete.)

23,181. "Improvements in and relating to electric traction systems." J. Mannheim. October 26th.

23,182. "Improvements in connection with vacuum brake apparatus and mechanism for use therewith on electrical and other railways." J. Gresham and H. A. Hoy. October 26th.

23,192. "Improvements in or relating to dynamo-electric generators and motors." A. D. Jones and the Jandus Arc Lamp and Electric Co., Ltd. October 27th.

23,224. "Improvements in electrically illuminated signs." J. H. Goehst. October 27th. (Complete.)

23,225. "Improvements in electric lamp sockets." J. H. Goehst. October 27th. (Complete.)

23,226. "Improvements in electrically illuminated signs." J. H. Goehst October 27th. (Complete.)

23,260. "Improvements relating to receiving instruments of printing telegraphs." P. A. Newtown. (Eltypic Manufacturing Co., United States.) October 27th. (Complete.)

23,285. "Improvements in telephone relays or repeaters." G. E. Sundquist and A. H. Wahl. October 27th. (Complete.)

23,318. "Improvements in devices for suspending the overhead conducting wires of electric tramways and railways." A. J. Howard. October 28th.

23,337. "The adjustable arm rest for the telephone." E. Moore. October 28th.

23,355. "Improvements in electrically-operated valves." The Warwick Machinery Co., Ltd. (The General Electric Co., United States.) October 28th.

23,359. "Improvements in sparking plugs and the like for electric ignition." F. H. de Veulle. October 28th.

23,375. "Improvements in electric silent discharge apparatus." A. Schneller and D. Koeleman. October 28th.

23,406. "The electric automatic twin wire switch." W. Parkinson. October 29th.

23,419. "A new or improved massage instrument for use with or without electricity." J. Fisher. October 29th.

23,443. "Improvements in electrical instruments." Crompton & Co., Ltd., and W. A. Price. October 29th.

23,444. "Improvements in electrical instruments." Crompton & Co., Ltd., and W. A. Price. October 29th.

23,461. "Improvements in or relating to electric generating apparatus," P. A. Rubens. October 29th.

23,469. "Automatic switch for control of starting electric motors," F. C. Newton. October 29th.

23,478. "Improvements in and relating to the electrical transmissions of energy through space." A. Artom. (Date applied for under Patents, Act, 1901, August 23rd, 1903, being date of application in Italy.) October 29th. (Complete.)

23,482. "Improvements in or relating to secondary batteries." G. Fosset. (Date applied for under Patents Act, 1901, November 24th, 1902, being date of application in France.) October 29th. (Complete.)

23,488. "Improvements in and relating to the electrical transmissions of energy through space." A. Artom. (Date applied for under Patents Act, 1901, September 12th, 1903, being date of application in Italy.) October 29th. (Complete.)

23,490. "Improvements in electric storage battery plates." O. Imray. (C. Potter, United States.) October 29th. (Complete.)

23,531. "Improvements in and relating to loose handle automatic magnetic blow-out circuit breakers." S. Whipp. October 30th.

23,540. "Improvements in electric resistance boxes." A. H. Adams and A. H. Curtis. October 30th.

23,545. "Improvements in or relating to electric batteries." A. Blackman. October 30th.

23,546. "Improvements in telephone mouth-pieces or receivers." A. B. Cruickshank. October 30th.

23,557. "Improvements in electrical clutch and brake mechanism." A. P. Steckel. October 30th. (Complete.)

23,574. "Improvements in wireless signalling systems." H. Shoemaker. October 30th. (Complete.)

23,585. "Improvements in electrical signalling apparatus for fire calls and the like." E. L. Pinching and W. H. Walton. October 30th.

23,592. "Improvements in electric circuit controllers." G. J. Philpott and G. H. Alderton. October 31st.

23,603. "Improvements in electric switches." J. Tomlinson and H. Lomax. October 31st.

23,636. "Improvements in raising and lowering electric arc lamps." W. A. Brown. October 31st.

23,647. "Improvements in and relating to electric arc lamps." J. McLaughlin. October 31st. (Complete.)

23,652. "Improvements relating to electric meters." Soc ete Anonyme des Ateliers de Mecanique de Precision de Territet. (Date applied for under Patents Act, 1901, November 10th, 1902, being date of application in Switzerland.) October 31st. (Complete.)

## PUBLISHED SPECIFICATIONS.

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Contact Arrangement for Ships' Compasses. B. Freese. 52. January 1st.

Telephone Systems. I. B. Birnbaum. (Telephone-Fabrik Actiengesellschaft vorm J. Berliner, Germany.) 134. January 2nd.

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Field Windings. W. P. Thompson. (Communicated.) 188.

Signalling and Controlling Apparatus for Railway and Tramway Systems. R. J. Sheehy and A. G. Curphey. 267. January 5th.

Surface Contact Electric Railway Systems; Preventing Short Circuits Therein. W. M. Brown. 330. January 6th

Storage Battery Plate, and Method of Making the Same. P. A. Newton. (C. Coster, United States.) 334. January 6th.

Lightning Arresters. H. H. Lake. (Mall Signal Co., United States.) 425 January 7th.

Electricity Meters. R. J. J. Swan. 459. January 7th.

Accumulators or Storage Batteries. F. Lauer. 582. January 9th.

Electrolytic Manufacture of Aluminium. G. Gin. 964. January 14th.

Trolley Arms used on Electric Tramcars and like Vehicles. J. W. Wilkinson. 1,006. January 15th.

Autograph Telegraph Systems. A. J. Boult. (Communicated.) 1,178. January 17th.

Appliance for Fastening Incandescent Electric Lamps in their Sockets. A. Landsberger. 1,221. January 17th.

Electrically Controlled Power-Transmitting and Speed-Changing Apparatus. L. J. Le Pontois. 1,320. January 19th.

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Trolleys and Electric Collectors. H. J. Haddan. (Communicated.) 1,432. January 20th.

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Method of Mounting Previously Formed Wire Coils in the Grooved Parts of Electrical Machines. Siemens Bros. & Co., Ltd. (Siemens and Halske Aktien-Gesellschaft, Germany) 2,196. January 29th.

Process and Apparatus for the Treatment of Gases, Vapors, and the like by Electric Spark Discharge. J. Schiutius. 2,199. January 29th.

Electric Switches for Controlling Circuits for Lighting, Heating and for Other Purposes. A. P. Lundberg and G. C. Lunuberg. 2,251. January 30th.

Electrical Power Systems, Especially Applicable to Railway and Tramway Vehicles. C. H. R. Thorn. 2,393. January 31st.

Storage Battery Systems. H. H. Lake. (C. A. Gould, United States.) 2,403. January 31st.

Electro-Magnetic Motors. A. P. Aguirre. 2,461. February 2nd.

Arc Lamps. Siemens Bros. & Co., Ltd. (Siemens & Halske, Aktiengesellschaft, Germany.) 2,502. February 2nd.

System of Electric Light Wiring and Tubing. J. A. Wilke. 2,544. February 3rd.

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